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THE HALLES OF YPRES.

AMONG other glories, the Flemings will have had that of causing the grand ideas that have influenced their history to rise in wonderful structures. By the side of religious thought, they have been able to give a civil application to that Gothic style which ever lends itself to all adaptations, but in which the adaptors have failed in other zones. It is just to say that the manipulation of an art so elegant, so delicate and so learned necessitated artists of rare ability. Ypres found these when it had need of them, and, thanks to them, it possesses one of the most interesting stone museums that stand between the Seine and the Escant. Its churches and its streets bear witness to a florescence of art before which one is astounded at the taste and refinement of the people who built in Gothic times. These tradesmen were truly endowed with wonderful intelligence. When they wished to have a gable end upon a street, they were anxious to be proud of it, and they have left nothing vulgar behind them. The most magnificent effort of the bourgeois of Ypres was the erection of those immense Halles in which they established the center of communal and commercial life.

And yet we must not ascribe all the honor to the entire corps of tradesmen, for the drapers played an important part in this work of indisputable grandeur and splendor.

This vast structure was erected in three periods, determined by Mr. Vandenpeereboom as follows: "It is probable that the first stones were laid at the end of the twelfth century (1200), and that the belfry, the eastern wing of the Halle or Old Halle, as well as the aldermen's chamber, were finished before 1230. The New Halle that is to say the structures as a whole to the west of the communal donjon, was built between 1285 and 1304; then, between 1362 and 1380, were constructed, first to the east of the Old Halle, various edifices forming dependencies of the scabinal seat, and finally the City Hall, which faces the choir of Saint Martin's Church."

The apsis of this church appears in our engraving behind another facade of later construction (1620–1623) which is a graceful specimen of Flemish renaissance. The structure as a whole occupies a superficies of 4,872 square meters, with a facade of 354 meters.

On the ground floor this facade consists of a long row of rectangular bays with horizontal lintel resting upon two brackets of peculiar form. The south and west facades are provided with two rows of windows of the same width, and not so high on the first story as on the second. All these windows are of primary ogival style.

Two coupled lancets, under a main ogive, are separated by a column with a foliaceous capital surmounted by a rose window.

At the top of the immense roof, which is surmounted by a crest formed of trefoils and ogival denticulations, runs a gallery with battlements and merlons carried by small columns resting upon corbels ornamented with figurines. Light oriels are placed at the east, west and north angles of the structure. At the center of the eastern facade rises the old belfry. Each of its four faces is provided with three rows of windows, some open and others figurative and all of primary ogival style. Upon its campanile, in which still rings the privileged bell cast in 1377 by the brothers Le Boom, has, since 1692, been shining the dragon of Ypres and the eagles gilded like itself.

Toward the end of the fifteenth century, great blazons were painted upon the roofs of the market and belfry. The campanile of the old donjon was also covered with gilding and polychrome decorations. It thus reflected, as Viollet-le-Duc says, the splendor of the independent and free commune.

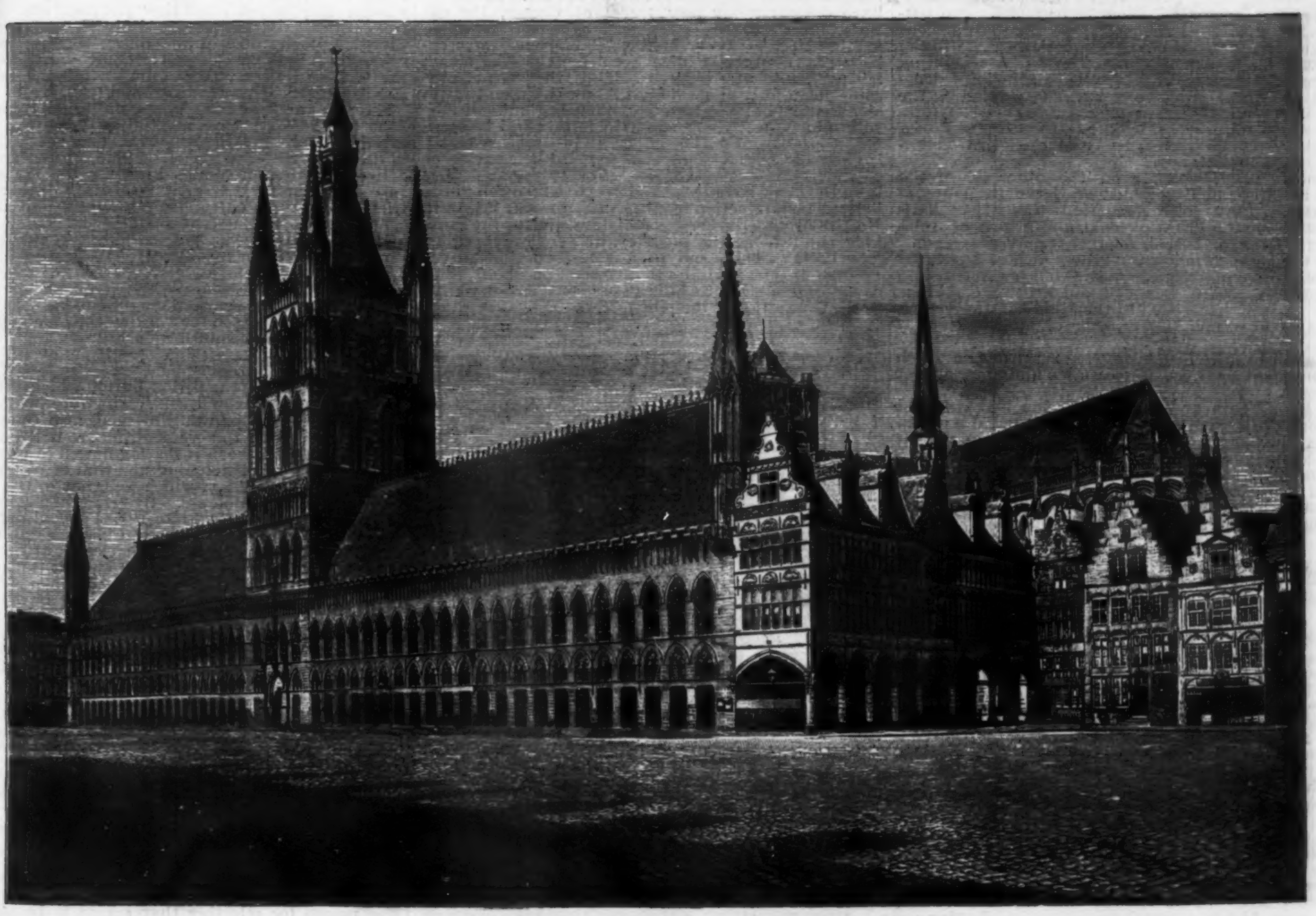
In 1377, a tabernacle ornamented with paintings and gildings, placed at the side of the belfry, received a statue of the Virgin, which afterward (1512–1600) served as a center to a row of statues of sovereigns bearing the title of counts of Flanders, and niched in the figurative windows of the southern facade. All these figures, destroyed at the end of the last century, were afterward restored and new statues were added to the first. These Halles, in addition to the communal administration, formerly comprised entrepots, dye works, carpenter shops, etc. Here also were held the privileged fairs that brought to Ypres French, German, English and Oriental merchants in large numbers, protected by safe conducts that guaranteed the security of their goods and persons.

The three stories of the belfry form three large square chambers. The first story served as a treasury to the commune. The prison and a depot of arms and war material occupied the second, and the third belonged to the bell ringing service. Above was installed the station of the watchmen, and from the top to the bottom of the donjon these chambers were provided with defenses designed, in case of riot, to arrest the revolted populace.

Life here was very intense in the thirteenth century. A population that may be estimated at two hundred thousand inhabitants worked and enriched itself in the shadow of the structure, but fought likewise, corporation by corporation, to conquer the bourgeois privileges. The communal movement, begun toward 1280, stained the city with blood up to 1340 perhaps, since the administration of the deans of trades in the grand council of the commune coincided with the reign of Jacques Van Artevelde.

In the fourteenth century, the population rapidly diminished and dropped to the figure of a hundred thousand souls. Still very powerful and very rich, it will see its splendor lessen from century to century through the events of war to which its situation exposes it more than any other city of West Flanders. But the independence of Belgium has been the signal there of a new activity. The Halles have anew attracted the solicitude of the commune.

Important decorative works have been executed in the interior of the structure—works of painting, since this art has there also acquired the privilege of great decorator. It has put the nineteenth century in this museum, a mark that our time will keep, in history, of having tried to decorate what others have been able to build.—Magasin Pittoresque.



THE HALLES OF YPRES.

PRESIDENT FAURE'S COUNTRY HOUSE AT HAVRE.

PRESIDENT FAURE'S house at Havre is situated in the Rue de la Cote, a delightful avenue surrounded by flowery gardens and well wooded parks. The house looks on to a grand view extending from the mouths of the River Seine down to the sandy end of the Calvados coast. Honfleur, Villerville, Hennequeville, Trouville, Deauville, Villers-sur-Mer, Houlgate-Beuzeval, Cabourg, the mouths of the Dives and of the Orne all

lie before you like a panorama. The foreground is occupied by Havre, with its harbor and pier, and the cliffs and villas of picturesque Sainte-Adresse and the Cape de la Hève.

M. Félix Faure bought the villa recently and added to its value by purchasing some park land adjoining. When it was bought the house had no room large enough for the President's receptions, which he is obliged to hold in spite of his holiday time, and M. Faure added a new wing, consisting of a large dining room on the ground floor, and a spacious cabinet de travail. The house, though of good size, is unpretentious in appearance, and if it were not for the "tricolor" flying on the roof and for the sentries at all the gates, nobody would suspect it to be the residence of the first citizen of France.

The ceiling in the large dining room has been painted by G. Clairin. In the adjoining Louis XIV salon the panels on either side of the black marble chimney piece are signed Toudouze, and represent "Spring" and "Summer." The smaller of the three salons en suite is specially devoted to Madame Félix Faure's Saturday afternoons "at home." Between those two is the white Louis XVI drawing room, where some charming pictures, bought by the President at last summer's Paris salons, are hung.

There is a pretty billiard room on the ground floor, for the President is a lover of that game, and hardly ever fails to enjoy a game in the evening with General Fournier, the general secretary of the presidency. M. Félix Faure is an early riser, and takes a ride every morning from six to nine before setting to work in his study and granting the appointed audiences.

The cabinet de travail is worthy of a fuller description. The furniture is in black waxed pear tree, Renaissance style. On the left is a large bookshelf with painted panels representing the Transatlantic mail packet steamer La Gascogne, painted by Ed. Adam (1886); Trébeudiri, a Greek boat, in front of the island of Syra, by M. Willenich (1886); a schooner, by Ed. Adam (1886); M. Félix Faure, as a commander of the Seine Inférieure Mobile Corps, 1870, by Ch. Lhuillier; a lighthouse on rocks, by Ed. Adam (1886); the bombardment of Foo-Tcheo (Willenich, 1886); and a naval battle. On the top of the bookcase there are ancient vases and weapons of savage countries. Close to the bookcase there hangs a pretty water color painting by Frederic Regamey (24 Mars, 1895), showing fencers of all periods in an allegorical group surrounding the bust of "Sainct Didier, premier maistre d'armes françois," and a bronze copy of the Uffizi gladiators on a pedestal. In another corner is a large engraved portrait of Gambetta.

Another large bookcase on the other side of the room is surmounted by a bust of Carnot, a figure of L'Alsace, a terra cotta statuette of the city of Paris attacked by the Prussian eagle, and a bust of Jules Grévy. Over the busts is another trophy of weapons. Near the corner window is a bronze bust of President Faure, surmounted by a banner of honor presented on June 6, 1895, by the wounded and decorated soldiers of Saint-Jean-d'Angély. In the middle of the room is the table at which the councils of ministers sit at Havre.

The table shown in our drawing is the one on which the president signs the decrees, laws, and other acts of the state.

M. Félix Faure and family have lunch at 12:15 and dinner at 7:45. General Fournier, the naval aide-de-camp, the officer d'ordonnance, and the lieutenant who commands the day's guard, lunch every day with the family. Madame Faure's informal parties have given her a reputation for hospitality, a reputation which is almost without a rival in a country renowned for its hospitality.—The Graphic, London.

THE FUTURE OF THE TURPENTINE INDUSTRY.

In a communication to Garden and Forest of July 10, 1895, L. J. Vance gives his opinions of the "Future of the Long-leaf Pine Belt," and as this is intimately connected with the turpentine industry, we reproduce it as follows:

A few weeks ago, when I was in the pine district of the South, every evening the sky was illumined by a dull red glare, and in the daytime the horizon was obscured by a thin veil of smoky haze. The cause of this was the turpentine industry, which has now reached its busiest season.

Few people who have not been in what is called "the long leaf pine belt" of the South can have any real idea of the extent of the damage done to the country by the turpentine workers and by the lumbermen, both of whom conduct their business on what has been bluntly called "the robbing system." They have left immense areas of land robbed not only of its natural resources, but in a worse condition for clearing and culture than before their invasion. Such is, without doubt, the case of many square miles in the two Carolinas, in Georgia, in Alabama and in Louisiana.

The result is that the most bare and barren places in all the South are those that have been visited by the army of turpentine gatherers. Every Northern visitor familiar with well ordered and cultivated farm lands and houses is struck by the great tracts of Southern country on which there is no vegetation of any value. These wastes are deserted and uninhabited, except here and there by the negro's lonely cabin.

The loss from fires is enormous. The turpentine workers are so careless and indifferent as to allow fires to run through the tracts in which they have worked. The resin on the scarified surface of the trees burns like kerosene; a spark, a blaze, and all at once a disastrous conflagration is sweeping through the pine forests with great fury, destroying millions of feet of marketable timber, and leaving hundreds of acres a scene of awful ruin.

This is no highly colored story, but a plain statement of what has been going on in the pine belt for years. Now and then protests have been raised against the reckless manner in which these forests are being destroyed, and yet very little has been done either by private or by public action to protect one of the greatest resources of the Southern States.

This is the more remarkable when we consider the enormous wealth represented by the long leaf pine belt. There is a strip of pine forest about one hundred miles wide that begins in North Carolina and follows the Atlantic and Gulf Coast plain to Texas, crossing six States, and covering an area of about 130,000 square miles. At a rough estimate, there may be 50,000,000,000 feet standing in this area, and if we take the values of timber and turpentine, the annual product of the forests of the South will approach in value the product of her cotton fields.

The pineries of the South now yield naval stores worth nearly $10,000,000 a year. The total production amounts to 340,000 casks of spirits of turpentine and 1,490,000 barrels of resin. In order to produce this enormous yield, some 2,500,000 acres of pine forest are being worked and nearly 1,000,000 acres of virgin forest are invaded annually. Now, no one will claim that these pineries are inexhaustible, for there has

PRESIDENT FAURE'S VILLA AT HAVRE.

actually been a decline in the production of naval stores within the past eight or ten years. The reckless cutting and tapping of trees have made great inroads into the magnificent stretch of pine. Railroads have opened many new tracts of timber, the old water mills have been replaced by steam saw mills, and, when the supply in the neighborhood was exhausted, tram roads have been built or the steam mills taken to new territory. Thus, the work of consumption and denudation has been carried on to such an extent that fears are just now beginning to be entertained that these valuable forests will be sacrificed to the greed for immediate and temporary gain.

The truth is, the long leaf pine belt is the backbone of the South Atlantic States. For 150 years it has been the chief resource of the people who dwell in the belt. The production of pitch and tar was begun in North Carolina during colonial days, and, as the State took the lead in the industry, its people were called "tar heels." There has been a heavy decline in the production of naval stores in North Carolina. This decline, amounting to fully 40 per cent., is due simply to the exhaustion of the pine forests. Of course, much

DRAWING ROOM, PRESIDENT FAURE'S VILLA.

has been written on the destructive agency of the turpentine industry, and many suggestions have been made regarding changes and improvements which are necessary. It is agreed that the turpentine industry, as carried on in the United States, results in great loss and damage, directly and indirectly. Compared with the way in which the French gather turpentine, our methods seem crude, wasteful and almost irrational.

The American turpentine workers still continue to follow the old time methods of tapping the trees for their sap. They have made few changes, and have adopted few improvements. They cut a deep, broad "box" at the base of the tree, and then the surface above the box is laid bare. The trees are worked for four or five seasons, when they become practically exhausted of their sap. The forest is then abandoned to the elements, to the bark beetles and pine borers, and, finally, the splendid trees are blown, burned or cut down. The French turpentine worker cuts no deep box into the tree, but uses a pail, into which the resin or crude turpentine is conducted by a gutter. He makes only a small chip about three or four inches wide, and this is enlarged from time to time. After five seasons' working, the trees are given a rest of several years, and so, by alternating periods of tapping and of rest, a tree can be profitably worked for fully fifty years. The French also take measures to regenerate their pine forests and to keep the trees strong and uniform.

If our turpentine workers understood the first principles of forestry, they would modify their destructive methods. With more knowledge based on experience, the day will come when the Southern people will see that good husbandry consists in managment, not destruction, of their forest resources; that some precautions and some protection are necessary against fire, as well as individual greed; that the present policy of the turpentine workers is lamentably wasteful and shortsighted; in other words, that it is more profitable to work the pine forests for fifty years, instead of five years; and, finally, that the lumber and turpentine industries, while changing the face of nature, and even the climate of the country, are slowly, but surely, making loss and trouble for this and succeeding generations.

THE GUM BENJAMIN INDUSTRY IN SIAM.

The gum benjamin tree is large and tall, and has a heart similar to that of the "teng rang" (a species of Shorea) and "phayom" (a kind of mahogany). In its general character, and in the form of its leaves, it resembles the "takieu" tree (a forest tree of hard wood, used for making dug-out boats). The gum benjamin tree is propagated from the original fruit. This, when fallen and lying upon the ground, takes root and sprouts after the fashion of the "phayom" and "gang" trees. As regards the trunk of the gum benjamin tree, there is no one who uses it. Gum benjamin trees are generally found on elevated ground and do not like the plains country. They grow in isolated patches, like the forests of "teng rang" and teak.

A forest patch of gum benjamin usually contains from fifty to sixty trees and upward, and the tree is found generally in large numbers along the high hills in the extensive forest region of Sina Phan, Tangslok, and the borders of Muang Theng in the province of Luank Prabang. It is rarely met with in other countries, except those outside the provinces immediately contiguous to Siam. The Siamese Thai, Annamites and Tongsoos, who have settled in the above mentioned provinces, have worked out and traded in the gum benjamin from an early period for successive generations, and these are scattered among the neighboring people, as well as being frequently found in Siam also. The season for working the gum benjamin is from the eighth or ninth months (July and August) to the tenth and twelfth months (September and November), when the season ends.

Thenceforward is the period during which the gum benjamin is bought and sold. The gum benjamin is worked after the following methods: So many trees are notched, so as to form a girdle around the stem. An interval of three months is allowed to elapse between the period of notching and that of picking the gum benjamin dammar, which wells out of the trunk and collects in the notches. By means of a sharpened stick or the point of a knife this is picked out, bark and all, and gathered at once in baskets. It is then sorted and divided into different classes, according to choice. Picking cannot commence before the interval of three months has elapsed, as the dammar that has trickled out into the notches would not have time to harden. It would still be soft and sticky, and if picked at the time would become dirty, owing to the bark coming off with it; nor would it be of such value either as, being sticky, it would cling to other things and the full benefit would not be derived, such as would be the case if it were properly dry. For this reason the gum benjamin must be left for three months after the notching, in order that all the gum possible may well out, and it may become dry and hard. Among the people above mentioned the picking and sale of gum benjamin is generally considered as one way of obtaining a livelihood, for the gum has a value and is reckoned as a marketable commodity. And even if the people have no other occupation than selling gum benjamin, that by itself is sufficient as a means of livelihood.

The period during which the gum benjamin is sold is not necessarily confined to the eighth or ninth months. The reason for selecting that season is because the people of those parts have many other things to do; for instance they have to plow the fields and reap their rice harvest. In the eighth and ninth months their work on the paddy fields is finished, and they can therefore turn their attention to gum benjamin. For this reason there is a special season. Their paddy fields are their first care, and then the gum benjamin trade. Those who have no business with plowing paddy fields and planting rice can, if they wish, work continuously at gum benjamin, at all seasons and during every month of the year. The gum benjamin trade requires no very great outlay of capital.

All the implements required are one large ax, a rice basket and an open woven basket. If a person wishes to work alone, without servants to assist him, he can do so: for in the first stages there is nothing much that requires to be lifted or carried. The only labor necessary would be when the gum benjamin is being picked and placed in baskets, and has to be carried to the temporary or permanent home of the picker. The profits gained on any one particular occasion or another can hardly be gaged accurately. Those who work out much sell at a large profit; those who work out little sell at smaller profit. One catty (133⅓ pounds) and upward would be considered a large output. Picked gum benjamin is sorted into three classes.

The best class, and that which fetches a high price, is called "slua," and is that which is sold in large lumps, and is not dirtied by the presence of bark. The second class is that left over from the first class, and is

in somewhat smaller lumps than the latter, and has some, but not much, bark attached to it. This is inferior in quality to Class I, and is half the value. That is to say, if Class I is sold at 75 ticals, Class II would sell at 37½ ticals. The third class is that left over from Class II. This class has bark attached to it, is soiled with dust and dirt, and is in small, fine pieces. It is called "mun," and is half the value of Class II. The price of gum benjamin, as sold in the jungle districts where the gum is worked, is as follows: Class I, one Chinese catty (66⅔ pounds), 100 or about 75 ticals. Class II, half the price of Class I. Class III, half the price of Class II. The price in Bangkok is: Class I, one Chinese catty, 260 ticals, as it has always been.

The gum benjamin trees that grow in the jungle districts referred to are not the subject of disputed ownership by one person more than another. Any one who wishes to work gum benjamin has merely to go into the jungle, search for and notch as many trees as he pleases, like people, for example, who go into the jungle to cut posts for their houses. Nor is there any tax or other emolument accruing to the country from either the trunk or the gum of the gum benjamin tree; nor is the gum benjamin trade one in the prosecution of which much thieving or fighting arises, whether it is because there are many people together at a time, or because, being in the jungle where there are fierce tigers, one man cannot steal along alone by himself, but is obliged to travel with parties, and so robbery and theft are rendered impossible, is uncertain. This gum is sweet scented, and is much used in mixing either with medicines or scents of various kinds. For whichever of these purposes it is sold, it always fetches a high price, like other valuable commodities, and for that reason gum benjamin is an article of commerce which merchants have bought and sold from time immemorial to the present day.—Kew Bulletin.

AN ORE TESTING PLANT.

By H. C. CUTLER, B.E.M.

THE ore testing plant, recently erected on the campus of the University of Minnesota, at Minneapolis, is a valuable addition to the equipment of the School of Mining and Metallurgy. The development of this school made it necessary to have some place where ores could be tested, their value determined and the best method of treatment ascertained, in order to give students practical experience in the different processes used in the treatment of ores and in handling various kinds of machines. This plant fully answers all requirements and has been pronounced by experts the best equipped and arranged plant in the country, if not in the world.

The building is of brick and stone and cost about $5,000 to erect. It is situated upon the bank of the Mississippi River, the slope of which affords the necessary drop for the series of levels, thus allowing the force of gravity to move the ore through the different machines. The machinery costs about $6,000, is full size and representative of that found in any of the Western mills. The following is a list of the principal machines: A ten by four Blake crusher; a Bridgeman sampler, size B; a preliminary screen; a series of trommels; a twenty foot link belt elevator; a pair of twelve by twelve inch geared rolls; a four compartment spitzkasten; a three compartment Hartz jig; a Collum jig; a three and one-half foot Huntington mill, a three and a five stamp battery with feeders; a four foot Frue vanner; a twelve foot buddle; a three foot amalgamating pan; a five foot settler; a Bruckner roaster; a reverberatory roasting furnace; a chlorinating barrel; three McDermott automatic samplers and a number of leaching and settling tanks. The entire plant is operated by electricity, two 20 h.p. D. & D. motors used for that purpose.

The main entrance to the building opens into the sampling room (twenty-three by thirty-one feet), which has a hardwood floor for careful hand sampling. From this floor the ore is taken by a five ton Reedy elevator up to the crushing floor, the highest level in the building. Here the ore is crushed, passed through a chute into a bin, then into the Bridgeman sampler, unless the sampling is to be done by hand, in which case it passes directly to the sampling floor.

From this point the ore may be turned in three different directions: First, it may be roasted; second, it may be sized and tested by coarse concentration; third, it may be delivered to a stamp mill on a lower level for fine pulverization and subsequent fine concentration. A different set of machines is required for each of these processes. The different methods will be followed briefly in order to show the perfect equipment and arrangement of the plant.

First.—The ore is shoveled from the sampling floor into the hopper of the rolls. From the rolls it is delivered by the bucket elevator to a preliminary sizer in which a screen of any mesh can be used. The ore, which is coarser than the mesh required, returns to the rolls, is broken up finer and is again conveyed to the sizer. After all the ore has passed the screen, it is wheeled on a platform extending from the sampling floor, out into the roasting room, and dumped into the hopper of one of the furnaces. The roasted ore can then be treated by the chlorination process or by any one of the various leaching processes, depending upon the nature of the roast.

Second.—If the ore is to be treated by concentration, after having been sampled, it is conveyed to the rolls; from the rolls the bucket elevator delivers it to a series of trommels or sizing screens. The material that does not pass the largest screen is returned to the rolls and again to the trommels. The various products are then delivered to a coarse concentration floor on a level below, where they are treated in the spitzkasten, the two-compartment Collum jig or the Hartz jig.

Third.—If the ore is to be treated by the third method, it is shoveled through an opening in the sampling floor into a car on the next lower level. From this car it is dumped into the feeder of either the three-stamp, five-stamp or Huntington mill. Upon the addition of water a pulp is formed. This pulp, after passing over an amalgamated copper plate, flows through launders to the Frue vanner on the next lower level. This machine yields two products, concentrates and tailings. The latter are carried either to the buddle, where they are reconcentrated, or to the amalgamating pan and settler, or run to waste, as the case may require. The concentrates from the vanner are taken to a steam drier, and after drying are roasted either in a reverberatory or Bruckner furnace for subsequent treatment by chlorination or lixiviation. The chlorination work is effected in a forty-eight inch Thies barrel chlorinator, where the gold is subjected to chlorine gas under pressure. The chloride of gold is leached out into tanks, where the metallic gold is precipitated and afterward taken out and refined.

Lots varying from five hundred pounds to a car load may be handled at this plant, and all known processes applied. The work is practical and gives training toward accuracy in methods and close economy in working—results which the modern professions of mining and metallurgy demand.—Year Book.

THE BY-PRODUCTS OF SLAUGHTER HOUSES.

IF only the edible portions of slaughtered animals were utilized, few persons could offer themselves the luxury of a beefsteak or cutlet, even for the Sunday dinner, in which good King Henry desired to see the "poule au pot" figure. Meat, already so high, would be of a prohibitory price, since about a third of the weight of the animal consists of products that cannot be eaten.

The utilization of such waste products therefore presents a considerable importance, and it is not without surprise that we have read an enumeration of them in a very interesting article recently sent us by Mr. C. C. Haskins.

Our readers are acquainted with those gigantic abattoirs, the stock yards of Chicago, which are not one of the least curiosities of this extraordinary city. Their importance is such that they have received no less than 9,000 steers, 1,000 calves, 15,000 hogs and 6,000 sheep in a single day. The market value of the by-products represents an enormous sum. The concentration of this industry in extensive works permits of reaping an advantage from products that small butchers would be forced to allow to go to waste. We shall follow Mr. Haskins step by step in his study.

The oxen are first slaughtered by a blow of a hammer upon the skull (Fig. 1). Each animal is immediately afterward seized by hooks fixed to its hind legs and suspended, head down, by a chain from a pulley that permits it to descend by its own weight along an inclined rail and to thus pass successively before a gang of workmen, each of whom performs a different operation.

The first workman cuts with the stroke of a knife the jugular vein and carotid artery, whence the blood escapes and flows over the floor toward reservoirs, where it is treated with a view to ulterior uses.

When the blood is cold it coagulates, and the fluid portion, which contains the soluble salts, is liberated. It is employed for sizing paper.

The best qualities of blood are employed in very large quantity for the refining of sugar. The raw sugar, containing numerous impurities, is dissolved in hot water in large reservoirs. With this solution there is mixed perfectly pure ox blood. The whole is submitted to an increasing temperature, and the albumen of the blood rises as a scum and carries along almost all the impurities in suspension. The sirupy mass is afterward filtered through cotton and then through bone black. This latter also is a by-product of slaughter houses, and is made of calcined bones.

Upon coming from the filters, the solution contains nothing but pure white sugar, which solidifies through the evaporation of the water.

The inferior qualities of blood are employed for other and little known purposes, such, for example, as the manufacture of buttons. It is very difficult to distinguish a button made of blood from one of hard rubber of the best quality. As well known, blood forms the base of hardened wood.

Finally, the poorest quality of blood, mixed with other by-products, is used as a fertilizer.

Other workmen in succession cut off the animal's head, skin the legs and cut off the latter, split the skin along the belly and remove it and throw it through an opening in the floor to a gang which prepares it with a view to its ulterior conversion into leather.

Other workmen seize the contents of the stomach and belly which have fallen to the floor, and, with extraordinary dexterity, separate the part that is to go to the press or the drying room, the portion that is to enter into the composition of fertilizers, as well as that which is to be converted into oil and then into margarine or butterine (Figs. 2 and 3).

During these operations, water flows in abundance.

FIG. 1.—SLAUGHTER OF OXEN AT THE ESTABLISHMENT OF ARMOUR & CO., CHICAGO.

FIG. 2.—MANUFACTURE OF BUTTERINE—VIEW OF THE PRESSES.

The floor contains numerous apertures and is formed of gutters through which this liquid, charged with detritus of all sorts, runs into reservoirs wherein the solid parts are separated, and then pressed and dried in order to be mixed with fertilizers, the final asylum of what cannot be utilized otherwise.

Previous to this, these reservoirs have been skimmed in order to collect the particles of meat and fat, which are sold to manufacturers of axle grease, soap and candles. The water is afterward evaporated and the residue is mixed with fertilizers.

As the tripe is an edible product, we shall not occupy ourselves with it. But aside from this we have the bladder, which, cleaned, inflated, tied with a ligature and dried, is sold to manufacturers of mastic, snuff, etc. As the bladder is impermeable, no evaporation occurs, and the objects that it contains preserve all their freshness. The druggist and the perfumer also employ it, for the same reason, for covering the corks of their bottles.

One of the guts is treated in the same way. It is about 7 or 8 centimeters in diameter and from 30 to 40 in length. It is very thin and transparent when it is inflated. Several of these guts are glued together, end to end, and are used in breweries for lining pipes, so as to prevent the beer from coming into contact with the metal. The intestines are prepared also for the use of goldbeaters. In this industry, an ingot of the precious metal weighing about 75 grammes is in the first place rolled between two steel cylinders until reduced to a sheet about 3 millimeters in thickness. After reheating, this sheet is cut into 25 × 25 mm. squares, which, separated from each other by sheets of parchment, are arranged in a pile and placed in a parchment envelope. The whole is then hammered until

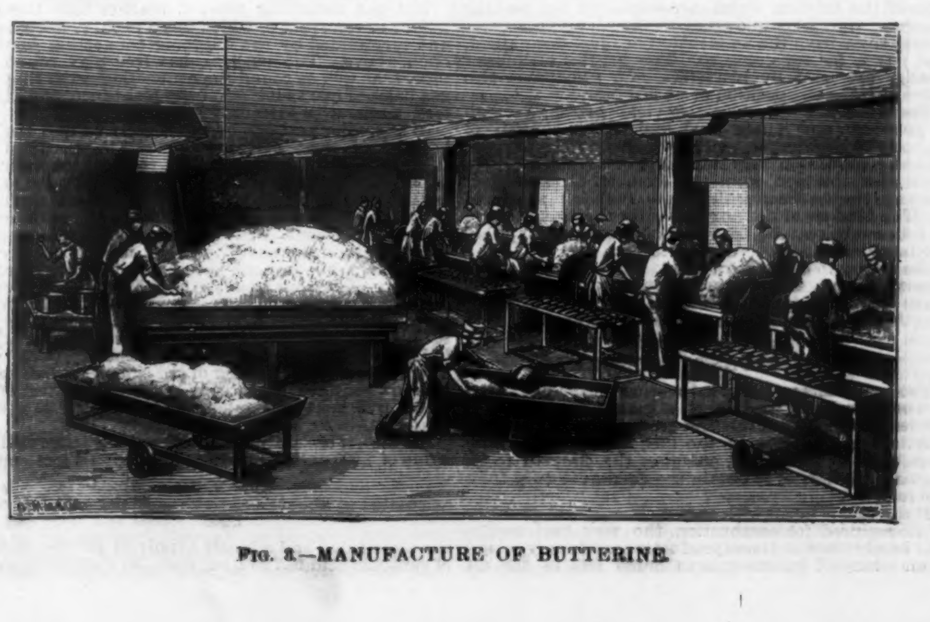


FIG. 3.—MANUFACTURE OF BUTTERINE.

the sheets of gold have become four times as wide. They are then placed in alternate layers with skin and hammered as before until their thickness is no more than about one ten-millionth of a millimeter. This delicate membrane is of considerable value. It is used also in surgery for closing wounds and for making plasters It is formed of the external membrane of the large intestine of the ox.

The manufacture of glue and gelatine (the latter of which is the same product as the former, made more carefully of selected materials) is effected with the byproducts of the slaughter house. The parings of skins, the ears, a portion of the tail, the feet, the muzzle, the bones that cannot be otherwise employed (such as those of the skull and jaws), the interior of the horns, etc., are used for this purpose. The hairy parts are first treated with lime, which serves to unhair them and preserve them. The lime is afterward neutralized with sulphuric acid, and the mass is separated from its impurities by washing. The gelatine is dissolved by ebulition, and the remainder falls to the bottom of the boiler. The solution is afterward reduced by evaporation and placed in boxes, wherein it hardens into a jelly, which is cut into slices by means of wire. These slices are afterward dried in a furnace until they are hard.

There is also made with particular care a sort of gelatine which is employed by brewers for clarifying beer. The gelatine in powder is thrown on the surface of the liquid and forms thereon a solid mass, which slowly falls to the bottom of the reservoir and carries along all the impurities.

The bones that are employed for the manufacture of gelatine are first treated with hydrochloric acid. The combination of the bones and acid serves for the manufacture of phosphoric acid, which has an important commercial value. A third of the osseous substance is thus collected in the form of gelatine or glue, and more than half in the form of phosphates of lime and magnesia renders up its phosphorus, which is sold in the form of acid.

The hair collected in these operations is not of uniform value. That which comes from the interior of the ears and is very fine is plucked out before all else, and, properly treated, is used for making "camel's" hair pencils, which are sold at a low price for the use of children. The feet, after being freed from horn, serve for the manufacture of an oil which is used for dressing leather. The horn serves for the manufacture of combs, buttons, etc.

The horns are used for a multitude of purposes. They can be made supple, be split into thin plates and pressed under the most diverse forms in heated moulds and receive various colors. They form close imitations of the highest priced tortoise shell. After being kept for a certain length of time in boiling water, the pieces readily weld, and, submitted to pressure until cold, preserve the form that has been given them. In this way are made umbrella handles, knife handles, tobacco boxes, goblets, napkin rings, etc. The comparative scarcity of whalebone has called attention to these products, which advantageously replace it, and are at the same time of more pleasing aspect. The breeding of animals deprived of these frontal appendages is tending to increase the price of objects thus manufactured, but this has not diminished the sale.

The different uses of bones are well known. According to their quality or form, they are employed in the manufacture of common objects, and in the preparation of fertilizers, gelatine and animal charcoal. The leg bones are in the most request for the second kind of manufacture, and are sold by the hundred.

The hair removed in the process of making glue is burned in a closed vessel, and serves for the manufacture of ammonia, which is used for making artificial ice in breweries and in cold storage houses where meat is kept. The tuft of hair of the tail enters into the manufacture of curled hair.

Even the indigested food found in the stomach of the animals is utilized. In it there is found hay and Indian corn, which, after being compressed and dried, forms a food known by the name of "Texas nut."

After being mixed with bone dust, blood and detritus of all sorts, the excrement serves as a fertilizer. All these substances, which are rich in phosphates, lime, magnesia, potash, and soda, are pulverized, and make an excellent fertilizer. Again, the bile, known under the name of ox gall, is used for cleaning and in painting and binding. The young calves furnish the rennet that is used for curdling milk in the manufacture of cheese. The rennet is found in the interior of the stomach. It is salted and dried, after being cleaned, and in this state may be kept for a very long time.

The same by-products are obtained from the hog as from the ox. Moreover, we may mention the utilization of the bristles, which are employed for making brushes. Special employes of the brush manufacturer collect these from the animal that has just been killed, and pay a fee for doing so. The bristles of inferior quality are used by plasterers, and sometimes also enter into the composition of curled hair.

The stomach of the hog also yields pepsin, a medical product now much used, and which consists of carbon, 53; hydrogen, 6·7; nitrogen, 17·8; oxygen, 22·5—a composition very near that of albumen. Pepsin is also obtained from the stomach of calves, but hogs are the most convenient and abundant source of it. The bladder of the hog serves for the manufacture of tobacco boxes, and, like that of the ox, for capping the bottles of druggists and perfumers.

We might, in conclusion, speak of the sheep, which furnishes wool and a much esteemed leather, but these facts are too well known and would uselessly lengthen this already long article.—La Nature.

ARNDT'S PATENT ECONOMETER.

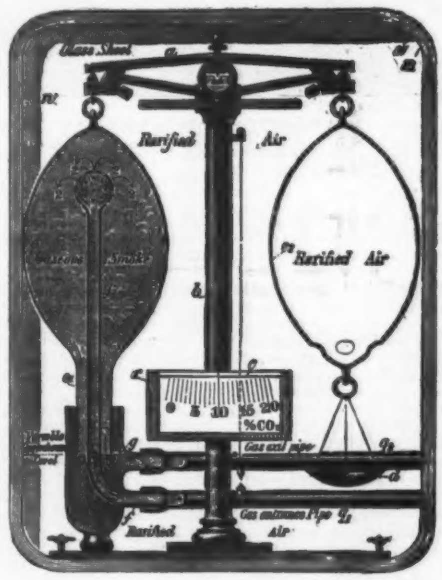
THE econometer is an interesting instrument that has been designed to show at a glance the degree of efficiency with which the fires are being managed, and has the same relation to the fires that the pressure gage bears to the steam, enabling the fireman to so regulate his fires as to obtain the maximum duty from the fuel.

If the fuel is burnt with only the theoretical quantity of air required for combustion, the very best results will be obtained in steam production, and every pound of air admitted in excess is so much loss, as the air must be heated to the temperature of the escaping gases, thus carrying heat up the chimney that should have been transferred to the water. It is, of course, impossible to work absolutely down to the theoretical limit, but the aim should be to keep as nearly to this as possible; and the econometer provides a ready means of obtaining this object. The maximum amount of CO_2 in the exit gases with perfect combustion is 21 per cent., and the losses attributable to excess air in increasing quantity will be seen on reference to the accompanying table.

TABLE OF THE LOSS OF HEAT AND FUEL IN STEAM BOILERS AND OTHER FURNACES.

	Index of Econometer	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Per cent. carbonic acid.
For coal of medium quality.	So there passes through the chimney	9·5	6·3	4·7	3·8	3·2	2·7	2·4	2·1	1·9	1·7	1·6	1·5	1·4	1·3	About so much more than the theoretical amount of air required for the combustion of the coal.
	That is, with a sufficient surplus supply of air 1·3 only, about 10·4 of necessary air for a kilo. of fuel, there must still be unnecessary about ..	65 6	40·0	27·2	20·0	15·2	11·2	8·8	5·6	4·8	3·2	2·4	1·6	0·8	0·0	Cubic metres of superfluous air heated at a temperature of various degrees, usually 250 deg. Cels.
																At a temperature of 250 deg. Cels. of outgoing smoke.
	And therefore the loss of fuel amounts to..	90	60	45	36	30	26	23	20	18	16	15	14	13	12	Per cent.

The econometer is fixed in an airtight case, n, with a sheet of glass in front. In the case, n, there are two connecting joints, i and i_1; the first, i, is connected by a pipe of about ¼ inch diameter, with the flue of the boiler between the latter and the damper; and the second, i_2, is connected by a similar pipe to a small aspirator in the flue between the damper and the chimney, and which is fed and directed by the draught of the chimney. In the interior of the econometer



case, n, the inlet 2 is connected with the ascending pipe, f, and the outlet 3 with the descending pipe, g, by means of India rubber tubes, q, q_2.

The gas weighing machine itself consists of a very finely adjusted, highly sensitive balance, a, to which is fixed the pointer or index, b. On one end of the balance, a, is suspended an open gas reservoir, e, with a capacity of about half a liter, and in the opposite end a hollow compensation body, e_1, to which is affixed a scale with a number of small weights, d, attached, by which the gasholder can be balanced. The edges of the balance are steel, gilded, and the points are agate.

The gas ascending pipe, f, reaches into the gasholder or reservoir, e, which has a neck, e, open below and surrounded by the outgoing connecting joint, g, open above. The neck, e, has free play round the pipe, f, as well as round the connection, g, so that the gas balance can swing free from resistance, and, therefore, works with extraordinary exactness.

In a circular sent out by the makers we find the following statements: "One kilog. = 2 lb. nearly of anthracite coal of medium quality, requires theoretically about 8 cm. of atmospheric air. If, for example, in the case of a steam boiler, and using a medium quantity of anthracite coal, the econometer shows an average of only 3 per cent. CO_2—a case often happening in practice—then the quantity of air used for the combustion of a kilogramme of coal and the almost equal quantity of gaseous smoke is about $8 \times 6·3 = 50·4$ cubic meters reduced to the temperature of 0° Cel. If the atmospheric air passes to the grate at a temperature of 20° Cel. and the gaseous smoke leaves the boiler at 270° Cel., the difference of temperature amounts to 250° Cel. Therefore, for this heating of the smoke—which on an average requires for raising each degree per cubic meter 0·32 heat unit—about $50·4 \times 250 \times 0·32 = 4{,}032$ heat units must be used.

Further, if the anthracite coal used has an actual heat value of 7,000 units, the loss of heat or fuel loss can be calculated at about $\frac{4{,}032 \times 100}{7{,}000} = 58$ per cent. If with the same firing and a larger supply of air the amount of carbonic acid fall to 1 per cent., so that the gaseous smoke contains 2 per cent. CO_2, the loss amounts at once to $8 \times 9·5 \times 250 \times 0·32 = 6{,}080$ heat units or to about $\frac{6{,}080 \times 100}{7{,}000} = 87$ per cent. of coal." It is not quite easy to understand what this means, or how the stated conditions could exist. It is clear, however, that no good boiler, properly fired and properly set, would waste 87 per cent. of all the heat to be got out of the coal. Taking the English figures instead of French, and assuming that 20 lb. of air will suffice per pound of coal, and that this air is discharged from contact with the boiler 500° F. hotter than it entered the grate, then the air would carry away $20 \times 500 \times 0·23 = 2{,}300$ units. If the coal represented 13,500 units, the loss would be 17 per cent. only. The apparatus is supplied by Messrs. Meldrum Brothers, City Road, Manchester. —The Engineer, London.

[Continued from SUPPLEMENT, 1034, page 16530.]

PUBLIC HYDRAULIC POWER SUPPLY.*

NOTES ON HYDRAULIC POWER SUPPLY IN TOWNS, GLASGOW, MANCHESTER, BUENOS AYRES, ETC.

By Mr. EDWARD B. ELLINGTON, of London.

AUTOMATIC Flow Recorders.—In order to maintain a sufficient control over all these sources of waste, it is of the first importance to know the minimum flow through the mains at times when it may be supposed that no work is being done. To ascertain this, automatic recorders are fitted at all the pumping stations. One of these is shown in Figs. 17 and 18; it consists of a drum, actuated by a clock, and carrying a paper strip, which is divided into quarters of an hour and hours by pins fixed on the drum; and over the drum are a series of armatures carrying pins, which prick a hole in the paper as each engine completes 100 revolutions. The ascent of the armature is determined by electric contact, and one armature is electrically connected with each engine. The clocks at the different stations are synchronized, and the paper tapes are cut off daily, and the maximum and minimum deliveries during an hour are registered daily. The maximum delivery is chiefly used for determining load factors, and the amount of power required for supplying a given number of machines, while the minimum daily registration is of the greatest value in determining the condition of the whole system, including the consumers' own machinery. The minimum flow varies greatly from day to day, but it never falls below a certain amount. This mode of registration was introduced by the author in 1888, and it has been found that the minimum flow rises pretty regularly as the supply is augmented. The following are the maximum and minimum registrations in London for the June quarters from 1888:

Year.	Total Water Pumped in June Quarter.	Maximum Flow per Hour.	Minimum Flow per Hour.	Annual Load Factor.
	Gallons.	Gallons.	Gallons.	
1888...............	29,238,000	39,120	1200	0·286
1889...............	39,873,000	49,920	1776	0·328
1890...............	48,172,000	61,248	1604	0·306
1891...............	65,386,000	79,320	3300	0·339
1892...............	77,103,000	91,920	3984	0·336
1893...............	82,586,000	101,760	4500	0·323
1894...............	96,876,000	114,096	4800	0·338

It will be observed that the minimum flow has increased at a greater rate than the maximum, and that the maximum has followed fairly closely the increase in output. The latter fact is more clearly brought out by the comparison also given for the same years of the load factor; that is, the ratio of the average flow per hour to the maximum flow.

The causes which have led to the comparative increase in the minimum flow since 1890 have been extremely difficult to ascertain. Since 1890 a great deal more hydraulic power has been used at the stations themselves, because most of the water from the river has since then been pumped into the unfiltered water reservoirs by means of hydraulic pumps; but as the hydraulic power so employed is registered, this should not have affected the ratios of efficiency, which have been lower for the years 1891-94 than in 1887-90. Recently arrangements have been made to stop for one hour on Sunday morning all use of hydraulic power at the stations; and during the current year the minimum flow has fallen to 4,080 gallons in the hour, with a delivery of 112,000,000 gallons in a quarter, and a maximum flow of 144,000 gallons per hour; these figures show as good a result as in any previous year. From such facts as these, and for other reasons, it appears probable that the principal cause of the differ-

* Paper read before the Institution of Mechanical Engineers.—Engineering.

ence is to be found in the meters and in the consumers' machinery.

Detection of Waste.—The whole of the 76 miles of mains in London are, as a rule, in communication with one another; but certain valves are kept closed in such a way that the several main circuits are in communication with one another at the central station only. The superintendent at the central station has it then in his power at any time to divide the supply into four distinct sections; and by observation of the pressure gages it can readily be ascertained through which section an abnormal flow is occurring. The main in which this abnormal flow is proceeding has then to be shut down at intervals, till at last the leak is run to earth. Great care and experience are required to determine the exact spot, as the water seldom appears through the surface of the street, and usually the only indication is the noise it makes in passing through a valve very slightly opened, which is detected through a metal rod pressed against the valve and held to the ear. Irrespective of any special indication afforded by the minimum readings, the whole of the mains are being constantly tested in this manner; but it is a work of considerable difficulty, because the supply has to be maintained as required throughout the night, and it is only during two or three hours in the early morning that anything of the kind can be done, and even then special arrangements have to be made with the consumers. The principal difficulty arises from the very small flows that have to be detected; for instance, the quantity of power water pumped into the mains and unregistered during the last quarter of 1894 was 6,900,000 gallons out of a total of 111,000,000 gallons, or 6·22 per cent.; but this 6,900,000 gallons to be accounted for by testing the mains is the result of water flowing continuously at the rate of say 3,000 gallons per hour, which is thus only about 2 per cent. of the maximum rate. The whole of this flow is distributed throughout 76 miles of mains, and over 2,200 machines, with all their pipes and accessories. At the pressure of 750 lb. per square inch, 3,000 gallons per hour would pass through an orifice of only $\frac{1}{16}$ inch in diameter; which shows how small in reality the leakage from the mains must be.

The principal source of waste is undoubtedly on the consumers' premises. It has been found necessary to inspect regularly all consumers' machinery, in order to prevent waste from leaky valves and glands. Every machine from which the exhaust is measured is thus inspected, every quarter, and the owners are called upon to make good defects. Many of the meters in use cannot be depended upon to register small flows, and a good deal of waste passing leaky valves thus fails to get registered; but some of the waste occurring in this way does evidently get registered, because it is almost invariably found that the quantity unregistered is less than would be represented by the minimum flow. Thus in the figures just given for the last quarter of 1894, about 30 per cent. of the minimum flow was registered. A further cause of loss has already been mentioned, namely, the drainage of pipes and cylinders on consumers' premises. This no doubt is the cause of the registrations being better in the summer quarters than in the winter. In severe frosts the drainage of the pipes and cylinders is an important matter, and it has been found advisable to facilitate the practice. There are other losses due to washing out and testing the mains, etc. Water used for testing extensions of mains is allowed for in the registered quantity. On the whole, therefore, it is no doubt a good result to have succeeded in registering an average of 93 per cent. of the quantity pumped during the nine years 1886-94.

Frost.—The severe and prolonged frost of last winter did not seriously affect the supply. About 1,150,000 gallons was pumped to waste during Sundays, in order to maintain the circulation; but after allowing for this, 91·65 per cent. of the total water pumped was registered. This fact alone is conclusive; but in a few places submains in exposed positions were frozen, though in nearly every case they were quickly cleared. No consumer, it is believed, was seriously inconvenienced. The frost was down in the ground quite 3 ft. in places, and there were five or six instances of broken mains. The damage done was greater than on any previous occasion. The surface of the roads was so hard that the water could not get through the paving, and in two or three places found its way into cellars. In two instances the water was forced between the concrete and the wood paving, floating the latter, and at last finding a vent about 100 yards away from the break. It was not found necessary to relay the pavement thus lifted, except in a few places, for it settled down all right again after the water had run off. There were other novel experiences of the severity of the weather. In the Thames Embankment subways there were several degrees of frost, and during its continuance, in order to reduce the risk, the area of supply was divided into sections, and the embankment main had thus a dead end; the temperature fell, the main contracted, a large number of the joints opened, and huge icicles formed round the flanges. As soon as this was discovered, the valve shutting off the City was opened, the water which is sent into the mains at 60° flowed through, and thawed the pipes that had contracted, and most of the joints again became quite sound.

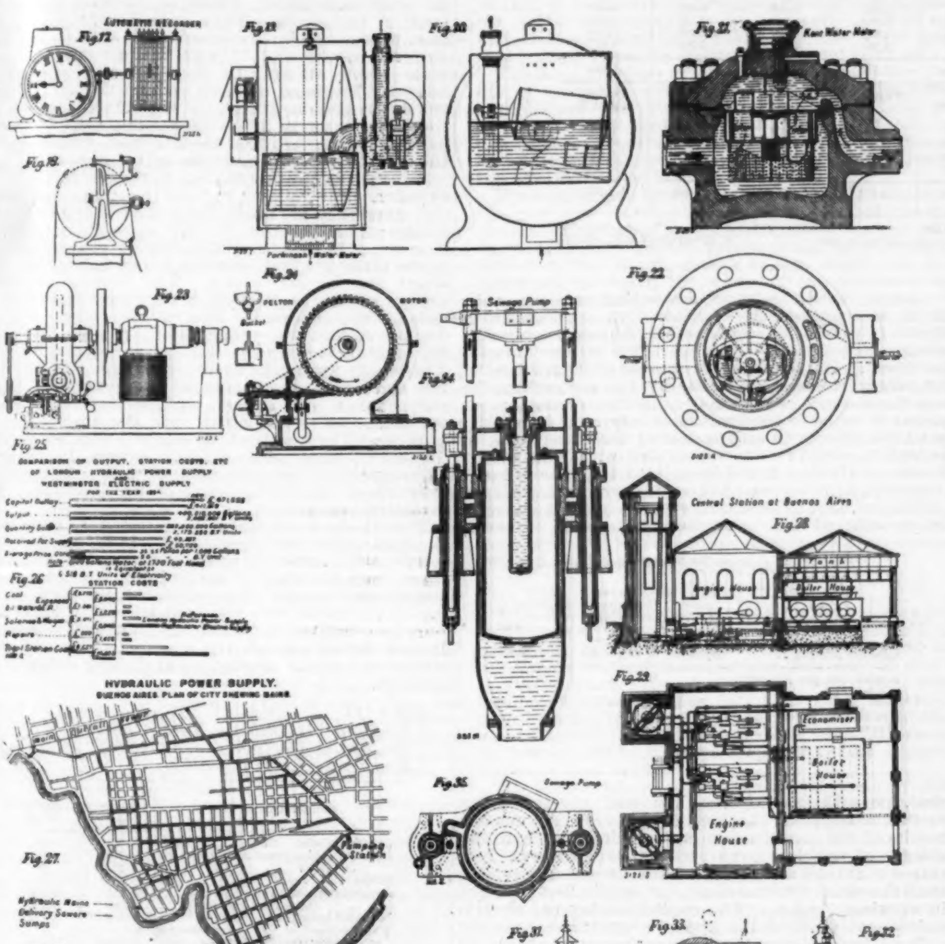
In connection with this question of warming the water, it is interesting to note that the water pumped from the river was below freezing point. The water is heated by passing it through the surface condensers of the engines; but at the new stations where the triple expansion engines are used, it was found that the temperature could not be raised much above 40° in the filtered water tanks; and in order to maintain the water at the higher temperature of 60°, it was necessary to destroy the vacuum in the condenser, thereby rendering the engine less economical for the time being.

Another experience may be mentioned in connection with low temperatures, which shows that high apparent economy is not always real economy. At the Wapping and City Road stations the economizers are arranged much in the same way as shown in Fig. 4 for the Glasgow works. The temperature of the gases leaving the economizers was reduced to 238° or 240°, and the temperature of the hot well condensed water entering the economizers was 65° or 70°. The consequence has been that it has been found necessary to renew the economizer tubes after three years' work, owing to the condensation on the outside of the tubes and their consequent corrosion. The cost of the renewal is larger than the saving of fuel effected. Arrangements are now being made to obtain a higher hot well temperature.

Meters.—At first sight it would appear desirable to use high pressure meters. Where these are used, the conditions of supply are much simplified, because the condition and arrangements of the consumers' machinery are then of no direct consequence to the works supplying the power, since all water taken from the mains for any purpose is measured; and this is undoubtedly the ideal arrangement. There are, however, difficulties in the way. The high pressure meters to stand 750 lb. to 1,200 lb. per square inch are necessarily costly. For hydraulic purposes it is essential, in the author's opinion, that they should be positive meters. A positive meter has three disadvantages; it will never for a long period register a small flow; it offers considerable resistance to the flow at high velocities; and if it gets out of order, it may stop the flow almost entirely. Now a stoppage of supply from any cause is more serious than a temporary failure to register; and the balance of advantages is found to be ultimately in favor of the low pressure meters registering the exhaust, from a tank into which the exhaust pipe discharges. The kind of meter adopted by the author is the Parkinson, illustrated in Figs. 19 and 20, which is closely similar to a gas meter. If it stops working, the tank overflows, and the nuisance causes a report to be sent in at once. It will register every drop of water, provided the water is clean and the meter properly set. On the other hand, it takes up a good deal of room; and if dirt or rubbish is allowed to pass into the drum, its accuracy is soon affected. A good deal of trouble is experienced from this cause. Where bad oil and packing are in use, or the glands and rams are in a bad condition, these meters have frequently to be changed two or three times in a single quarter; while in other places, where the machinery is better attended to, they will work for two years or more. With the Kent, positive low pressure meters, illustrated in Figs. 21 and 22, which are largely used in London, there is not the same difficulty, and in many places these are preferred, because the space taken up is so small and there is no noise from the falling water. But they do not register accurately a small flow. On the whole, they are well adapted for high pressure; and in several places it is only on the high pressure side that the power can be registered; as, for instance, at the London docks, where only a portion of the supply is taken from the hydraulic power mains, the remainder being supplied from the dock pumping stations. The principal difficulty with high pressure meters is in connection with the counter: the spindle must be light, in order to avoid loss of pressure; and the stuffing box must be kept tight under the wear. After passing 1,000,000 gallons they have been found under test still accurate within one per cent.

Application of Power.—Hydraulic power has to be supplied under competition with steam, gas, and electricity; and the success which has attended its introduction shows conclusively that it is well able to meet this competition for lifting and for other intermittent work. None of the supply systems which have been established have aimed at meeting the demand for continuously running motors, except in Antwerp, where the supply has been laid out as a means for generating electricity for lighting. At first sight it is somewhat difficult to see how this can be an economical mode of employment. There are, however, a few places in London where the hydraulic power is used to generate electric current. The best method of conversion is undoubtedly an arrangement such as is shown in Figs. 23 and 24. The apparatus consists of a Pelton wheel, with the armatures of the dynamo mounted on the same shaft. The following are the particulars of a trial made with this apparatus at the Hydraulic Engineering Works, at Chester, in October, 1894: Pelton wheel 18 in. diameter, 54 buckets; Elwell-Parker shunt-wound dynamo for charging accumulators, having a commercial efficiency of 87 per cent., as tested by the makers; speed 1671 revolutions per minute; bore of nozzle, 0·175 in.; hydraulic pressure, 725 lb. per square inch; output, 37¼ amperes at 120 volts; water consumption, 20 gallons per minute; power in water, 10·15 horse power; in output, 5·99 horse power; efficiency, 59 per cent. This is not the highest efficiency that could be obtained, for the wheel and dynamo were not perfectly adapted to each other; external resistance had to be used for keeping down the voltage, and at this output the dynamo was somewhat overworked. In a previous trial, with 0·16 in. nozzle and an output of 26 amperes at 122 volts, the efficiency was 59·86 per cent. It is unlikely, however, that, even under more favorable conditions, the conversion can be effected with a greater efficiency than 66 per cent.

Comparison of Hydraulic and Electric Power Supply.—It is interesting, therefore, to inquire whether there are any grounds for the assumption that hydraulic power obtained otherwise than from a natural head of water can be used economically for generating an electric current. It so happens that the materials are available for a comparison between the cost of a public supply of hydraulic power and that of electricity obtained from a central station on almost exactly the same scale. The particulars given in Table II, and plotted as a diagram in Figs. 25 and 26, are taken from the records of the London Hydraulic Power Company and of the Westminster Electric Supply Corporation for the year ending December 31,



PUBLIC HYDRAULIC POWER SUPPLY.

1894. In making the comparison, 1,000 gallons of water at 750 lb. per square inch is taken as equivalent to 6·518 Board of Trade units of electricity.

This analysis shows that the station cost of the hydraulic power is 5·172d. per thousand gallons pumped at the pressure of 750 lb. per square inch; while the corresponding cost of an equivalent amount of electric energy reduced to the same hydraulic standard, is 9·014d. per thousand gallons; or on the

sulting from this method of generating electricity on a large scale. It may be mentioned that the principal reason which led the late Prof. Van Rysselberghe to advise the combined method for the electric supply of Antwerp was that he considered the losses of distribution of the electric current would be much less on that method. The losses of distribution, however, are not very serious either way; and the direct or the combined method must ultimately stand or fall, the author

TABLE II.—COMPARISON OF HYDRAULIC POWER SUPPLY AND ELECTRIC SUPPLY, COMPILED FROM THE REPORTS OF THE LONDON HYDRAULIC POWER SUPPLY (L.H.P.) AND THE WESTMINSTER ELECTRIC SUPPLY (W.E.S.) FOR THE YEAR 1894.

1894.	Totals.		At Gallons at 1720 ft. Head.		At Board of Trade Electric Units.	
	L.H.P.	W.E.S.	L.H.P.	W.E.S.	L.H.P.	W.E.S.
	£	£	Gallons.	Gallons.	Electric units.	Electric units.
Capital outlay	471,552*	411,015				
Output	..	..	460,312,000	296,258,000	2,609,210	2,581,501
Quantity sold	..	..	333,396,000	333,480,000	2,106,590	2,173,296
Received for supply	49,237	50,770				
Average price obtained	..	..	Per 1000 gals. 35.55d.	Per 1000 gals. 36.51d.	Per unit 5.45d.	per unit 5.6d.
Station Costs.	Totals.		At 1000 Gallons at 1720 ft. Head.		At Board of Trade Electric Unit.	
	£	£	d.	d.	d.	d.
Coal	2,276	5,842	1.964	3.539	0.301	0.548
Oil, water, and engine-room expenses	1,351†	1,236	0.810	0.743	0.124	0.114
Salaries and wages	3,071	6,345	1.841	3.839	0.282	0.589
Repairs and maintenance	929	1,478	0.557	0.893	0.086	0.137
Totals	7,627	14,899	5.172	9.014	0.793	1.383
Individual station	Wapping §	Davies-street ¶	Wapping §	Davies-street ¶	Wapping §	Davies-street ¶
	£	£	d.	d.	d.	d.
Coal	1,242	3,263	1.684	3.906	0.258	0.609
Oil, water, and engine-room expenses	385	600	0.522	0.718	0.090	0.110
Salaries and wages	1,072	2,500	1.453	2.993	0.273	0.459
Repairs and maintenance	382	931	0.518	1.114	0.079	0.171
Totals	3,081	7,294	4.177	8.731	0.640	1.340

* Including 56,000l. for a new site and station, started October, 1894. † Including 400l. for water rights and 125l. for gas lighting. § Wapping Station only; output 177,000,000 gallons in 1894. ¶ Davies-street only; output 1,308,794 units in 1894, equivalent to 200,460,000 gallons.

electrical standard of Board of Trade units 0·793d. and 1·383d. respectively. The output during the year, the capital employed, and the average rate received for both supplies, are nearly the same. The coincidence of the figures is extraordinary, except in the cost items, in which their divergence is equally remarkable. No other conclusion can be drawn than that, for some reason or other, not hitherto explained, hydraulic power is much less costly to produce than electricity. The Westminster electric supply is one of the largest in the country, and its cost is one of the lowest. The London hydraulic supply is the greatest anywhere, and is produced, no doubt, very cheaply. In neither, however, has the minimum cost been reached, for in both of them the station cost in the newer installations is considerably below the average for 1894. For instance, the station cost of the hydraulic power supply from the Wapping station for 1894 was only 4·177d., as against 5·172d. for the whole supply; while the station cost of the Davies Street station of the Westminster electric supply is equivalent to 8·731d. per 1,000 gallons, against 9·014d. for the whole supply. It may be thought that the low annual load factor of, say, 0·18 for the electrical supply, as against 0·33 for the hydraulic, accounts for most of the difference; but under the able control of Professor Kennedy the influence of a low load factor has been to a great extent neutralized by running the machinery actually in use at nearly full load. Moreover, the figures of other electric installations, such as the St. James' and Pall Mall, where the load factor is much higher than in the Westminster district, show a similar difference of cost as compared with the hydraulic supply. Now, it is obvious from the figures of the London and Westminster installations that, as the output during the year was the same, while there is so great a difference in the annual load factor, the maximum horse power employed is much greater for the electric than for the hydraulic supply; but the output per unit of capital outlay seems to be much the same. This is, no doubt, owing to the greater concentration of demand in the area supplied with electricity. If a large amount of power is concentrated in a single station, it is practicable to work that station much nearer to its maximum capacity than if the same power had to be supplied from two or three stations. In the London hydraulic supply, while the annual load factor is 0·33, calculated on the maximum delivery at any time during the year, the load factor of the whole plant in use during the year under the most favorable conditions is only 0·20, and is often much lower; in other words, more than one-third of the whole plant is always in reserve, and in some years as much as half. The proportion of plant out of use altogether or not running at full load at the periods of maximum demand is, no doubt, much less at most electric lighting stations; and the load factors of the two systems, calculated upon the total station plant, probably do not differ widely. The fact that the load factor calculated on the maximum flow is lower for the electric supply than for the hydraulic does not, other things being equal, account for the larger part of the difference of cost. This is shown also by a comparison of the cost of the hydraulic supply during a week when the output is large and during another when it is small. During the week ending October 18, 1894, altogether 9,095,000 gallons were pumped at the London hydraulic power stations; and during the week ending December 27, 5,902,000 gallons only. The increased cost for fuel in the latter week was 0·317d. per 1,000 gallons, and for wages 0·77d. per 1,000 gallons, making 1·087d. per 1,000 gallons; whereas the average excess cost of the electric supply is more than 3½ times as much, and in the item of coal nearly five times as much.

The immediate question, however, is the economy of using hydraulic power for generating electricity; and it will be seen from the foregoing figures that, with a loss of 33 per cent. of the hydraulic energy during conversion into electric energy, the station cost of 0·793d. per Board of Trade unit would rise to 1·189d., or 0·194d. below the cost, 1·383d., of the direct current of the Westminster supply. The cost will be further increased by the wages, superintendence, and repairs at the converting stations, so that on the whole there does not seem much probability of any economy resulting from this method of generating electricity on a large scale.

considers, on the relative generating cost per unit. Mr. L. Moris has kindly furnished the particulars in Table III of the working of the Antwerp hydraulic service. The very low cost per 1,000 gallons pumped is evidently due to the small amount of wages paid at the central station; and the figures include nothing for superintendence, water supply, lighting of station, removal of ashes, or repairs to machinery. At least 1½d. per 1,000 gallons should be added for these items, in order to make the cost comparable with that of the London stations. It will be noticed that the reduced output in April increased the cost only 0·46d. per 1,000 gallons, or, say, 15 per cent., while the output was only 58 per cent. of that in January. It seems, however,

TABLE III.—*Antwerp Hydraulic Power Service.*

1895.	January to April. Four Months.	January. Maximum Month.	April. Minimum Month.
Quantity pumped ..	gallons 59,090,000	gallons 20,178,000	gallons 11,772,000
Station cost per 1000 gallons:	d.	d.	d.
Coal	2.618	2.483	2.614
Engine-room stores ..	0.118	0.110	0.134
Wages	0.693	0.512	0.840
Total	3.429	3.125	3.588

that, notwithstanding the low cost at which the hydraulic supply is obtained in Antwerp, the general results of the combined method during the first nine months of working have not been satisfactory. It is stated that the arrangements have proved more costly than the usual direct method, not only in first cost, but in working expenses. The capital outlay per electric unit would probably be greater; but there seems no sufficient reason why the working expenses should be increased. Further information is required before an explanation can be given. While the combined method does not seem to have any sufficient basis for a general system of distribution, it is evident from the foregoing figures that electricity can be economically generated by means of hydraulic power artificially obtained; and the latter can, therefore, be used with advantage as a supplement to ordinary methods of generating electrical energy.

Hydraulic power is clearly much the most economical in those applications where the direct pressure can be utilized, such as for lifting and pressing. Where rotary motion is needed, the special circumstances of each case will determine what power shall be used, and all are now more nearly on a par as regards cost. For motors running regularly for several hours a day the London Hydraulic Power stations now supply power at a rate of 1s. 6d. per 1,000 gallons, which is equivalent to 2·76d. per Board of Trade unit of electricity, or say 3d. per brake horse power per hour. It is questionable whether small powers can by any means be obtained at a lower rate, when all the items of cost are taken into account.

Hydraulic Power Supply for Drainage.—Hydraulic power mains have recently been put down in the streets of Buenos Ayres for the purpose of drainage; and although the supply is not intended to be sold to the public, yet the conditions are such as to render interesting a general outline of the undertaking, as an instance of a hydraulic power supply in towns. As engineer-in-chief to the works, the Hon. R. C. Parsons had a few years ago to face the problem of draining the two low-lying Boca and Barracas districts, which are indicated on the plan, Fig. 27. In order to avoid the great cost and difficulty of laying deep sewers, he ultimately decided to lay out the works on the plan of numerous small automatic pumping stations, and finally adopted hydraulic power as the best means for working the pumps at the sumps. The general plan of the works is shown in Figs. 28 and 29. There is a central station, containing two compound surface condensing horizontal engines, having cylinders 15½ in. and 27 in. diameter, with 22 in. stroke (Fig. 30); each engine works direct a double-acting pump of 5 in. diameter and 20 in. stroke, and is capable of delivering 175 gallons of water per minute at 58 revolutions. Space has been provided for a third engine, whenever the work to be done at the sumps renders necessary. There are three Lancashire boilers, 6 ft. in diameter by 22 ft. long, with a Green's economizer of 120 tubes. The roof of the engine house is a tank, which is kept supplied from the water works mains. The water after use is run to waste into the sewers. The engines can be run with or without the condensers, as it is sometimes inconvenient to use the water in the tank for condensing purposes, owing to the high temperatures during the hot season. There are two accumulators of 18 in. diameter and 20 ft. stroke, which were loaded at the trials to 800 lb. per square inch; but the machinery is calculated to work at 750 lb. per square inch under ordinary conditions. The station is fitted out with the usual accessories.

The mains carried through the Boca and Barracas districts are nearly 8¼ miles in length; and their arrangement is shown on the plan, Fig. 27. There is a duplicate supply to every sump. The largest mains are 5 in. bore and the smallest 2 in. bore. There are in all 17 sumps, one of which is shown in Figs. 31, 32, and 33. Each sump contains duplicate hydraulic sewage pumps on the author's system, Figs. 34 and 35. The quantity of sewage to be dealt with varies considerably at the different sumps; but it was found practicable to reduce the whole of the pumps to two sizes, and as a matter of convenience the only substantial difference between them was made in the stroke. They are all single acting, and have plungers 30 in. in diameter; 22 of them are made with 3 ft. stroke and 12 with 4 ft. stroke; the maximum speed of working is ten double strokes per minute. The head of water and friction on the delivery sewers are also different at the different sumps, and the diameter of the hydraulic working rams was varied to suit. The pressure on the side rams, which perform the upstroke, is constant; the water from these rams is returned in the downstroke to the central hydraulic cylinder. The sewage runs into the sumps by gravity, and when they are nearly full a float starts one of the pumps; and when the level falls a certain amount, the float stops the pumps. If the level of sewage continues to rise after the first pump is at work, another float starts the second pump. The pumps, therefore, always work so as to cause a flushing velocity in the rising main or sewers. The exhaust power water is discharged into the sewage pump cylinders, thus serving to dilute the sewage and keep the plungers clean. The whole arrangement is automatic. At the time the machinery was completed there were no houses connected to the sewers, so that the tests had to be made with water run into the sewers for the purpose. The results of the engine's tests are given in Table IV, below. The delivery sewers discharge at different points into the main outfall sewer, which is everywhere above the level of the Boca and Barracas drainage area.

The whole of the mains were tested to 1,500 lb. on the square inch after being laid. In laying them during the hot weather, it was found necessary to protect them from the heat of the sun, in order to preserve their correct length. The whole of the work, including all the mains, was prepared in such a way that it was unnecessary to obtain any making-up pieces in Buenos Ayres, and all the machinery for each sump was erected in the workshops at Chester before being sent out.

Table IV. — Hydraulic Power Supply for Drainage in Buenos Ayres. Trials of Two Compound Horizontal Condensing Pumping Engines at Central Station.

November 21-22, 1893.	Engine No. 1.	Engine No. 2.
Duration of trial .. .. .. hours	10	10
Diameter of high-pressure cylinder .. in.	15½	15½
" low " " .. "	27	27
Stroke .. .. "	22	22
Revolutions, total during trial ..	35,150	35,030
" average per minute ..	58.58	58.38
Indicated horse-power, mean ..	119.131	120.787
Water pumped at 800 lb. pressure per square inch, total during trial .. gals.	106,293	105,931
Water pumped, average per minute ..	177.15	176.55
South Wales coal fed into furnaces, total during trial, ash, &c., not deducted .. .. lb.	2364.51	2192.47
Coal per indicated horse-power per hour .. .. lb.	1.97	1.81
Coal per pump horse-power per hour ..	2.37	2.22
Boiler pressure per square inch above atmosphere .. .. .. lb.	100	100

It will be seen from Table IV that the coal per indicated horse power was 1·89 lb. per hour, and per pump horse power 2·29 lb. per hour. Taking the average efficiency at the sewage pumps at 50 per cent.,* including all losses in the mains and valves at the highest speed contemplated, the expenditure of coal is 4·58 lb. per pump horse power at the sumps. This shows that 41 per cent. of the indicated horse power of the engines is recovered in useful work at the sumps.

The pumps have to work under most variable conditions, and are situated at 17 sumps distributed over an area of nearly two square miles, requiring over eight miles of mains to connect them with the central station. The economy to be obtained under such circumstances cannot be great; and it is believed that no other method of distribution has shown such good results under similar conditions. The Hydraulic Engineering Company, Chester, were the contractors for the construction and erection of the whole of the plant; Mr. F. W. Thornton had charge of the erection of the machinery and laying of the mains for them.

Hydraulic pumps of the same kind as those at Buenos Ayres have been for some years at work, pumping the water from the River Thames into the reservoir tanks at the London Hydraulic Supply stations. At Falcon Wharf, Blackfriars, the head is about 80 ft., including friction in the rising main; and the efficiency of the pumps is 75½ per cent.

* The actual efficiency of the pumps with the higher lifts of 20 ft. to 28 ft. was considerably more; but at the lower heads of 10 ft. to 15 ft. the efficiency was necessarily reduced.

IN Malta, bees are plentiful, and bee-stings are in such repute as a cure for rheumatism that resort to this primitive method of inoculation has been in common practice in severe cases for generations, the results, it is said, having been most satisfactory in the patients.

STOPPING, STEERING AND RESISTANCE OF FLOATING VESSELS.

By JOSEPH R. OLDHAM, N.A. and M.E.

REFERRING to the steering of screw steamers, Sir Nathaniel Barnaby states that when a screw is suddenly reversed, and before the headway is off the vessel, the action of the rudder is not to be depended upon. The following is an extract from the report of the committee appointed by the British Association to investigate the effect of propellers on the steering of vessels.

The committee endeavored to ascertain how far the reversing of the screw in order to stop a ship did, or did not, interfere with the action of the rudder during the interval of stopping. The report states:

It is found an invariable rule that during the interval in which a ship is stopping herself by the reversal of her screw, the rudder produces none of its usual effect to turn the ship, but that under these circumstances the effect of the rudder, such as it is, is to turn the ship in an opposite direction from that in which she would turn if the screw were going ahead. The magnitude of this reverse effect is always feeble and is different for different ships, and even for the same ship under different conditions of loading.

It also appears that, owing to the feeble influence of the rudder over the ship during the interval in which she is stopping, she is then at the mercy of any other influence that may act upon her. Thus, the wind, which always exerts an influence to turn the stem or forward end of the ship into the wind, but which influence is usually well under control of the rudder, may, when the screw is reversed, become paramount, and cause the ship to turn in a direction the very opposite of that which is desired.

Also the reversed screw will exercise an influence which increases as the ship's way is diminished to turn the ship to starboard or port, according as it is right or left handed, this being particularly the case when the ship is in light draught. These several influences, the reversed effect of the rudder, the effect of the wind and the action of the screw, will determine the course the ship takes during the interval of stopping.

They may balance, in which case the ship will go straight on, or any one of the three may predominate and determine the course of the ship.

The pressure on the screw blade which is moving in the same direction as that in which the stern of the vessel is turning is increased, while on the blade moving in the opposite direction the pressure is reduced, that is to say, if the screw is right handed and the vessel is under port helm, the stern, consequently, traveling to port, the resistance of the lower blade which is moving toward the port side will be increased, and the resistance of the upper blade, which will be moving toward the starboard side, will be diminished, because the one is meeting the water and the other is receding from it. The change of pressure will be proportional to the square of the angular velocity of the stern. The irregular pressure causes the vibration frequently noticed when a screw vessel is rapidly turning.

I think the opinion, or I may say the conviction, is not uncommon among those connected with the working of high speed, fine line steamers, that the great power of their engines will generally enable them to arrest the forward motion of the hull in less time and space than is required by comparatively low speed vessels, and reasoning thus it is sometimes assumed that their inability for rapid maneuvering through high efficiency of the rudder power alone is not of so great importance.

This assumption, however, is not borne out by some careful experiments made under the direction of Professor Osborne Reynolds, to discover the best rules for the guidance of ship captains in endeavoring to avoid collisions. From this it appears that the distance required by a screw steamer to bring herself to rest from full speed by the reversal of her screw is independent, or nearly so, of the power of her engines, but depends upon the size and build of the ship, and generally lies between four and six times the ship's length.

As to the effect of shallow water on the steering of vessels, Mr. White states that it is a matter of common experience that ships which are perfectly under control in deep water steer wildly and require careful watching when they are navigating in very shallow waters, and have their keels only a few feet from the bottom.

This is well understood by lake shipmasters and others, and as our most intricate navigation is in shallow waters, it would seem to require no further argument to show that high efficiency in steering by a rudder is of the utmost importance on these rivers and lakes.

As regards the form or contour of rudders, it may assist in arriving at sound conclusions on this head if I touch briefly on the resistance offered by water to the motion of floating bodies. The effect of hydrostatic pressure on floating bodies appears to be very imperfectly understood. For instance, with regard to surface friction of a ship moving through the water (and of course the rudder is part of a ship), some authorities maintain that a square foot of surface, say on the side of the keel of a deep ship, meets with no greater frictional resistance than an immersed square foot near the load water line, while others assert that the friction augments in the same ratio as the hydrostatic pressure.

Mr. White says: "If there be no surface disturbance, the resistance at any special speed is independent of the depth, and this is equally true of the resistance to direct and oblique motion of a body through water."

Col. Beaufoy ascertained the resistance of a plate moving normally to itself, when submerged to depths of three, six and nine feet below the surface, and found them practically identical at all the depths. On the other hand, Mr. Seaton maintains that the friction of the water per square foot of surface will depend on the pressure directly, so that the resistance from a square foot near the water line is very different from one twenty feet below it.

The success of torpedo boats depends almost wholly on their lightness of both hull and machinery, enabling them to do with so small a displacement that they literally skim the water, and the pressure per square foot of wetted skin is consequently very small. Unless small boats are made to float at a very light draught, they cannot be driven at high speeds, and all experiments with fast river steamers on the Clyde and elsewhere have shown this. From this and other experiments it would seem that the smaller the surface of the rudder at and near the keel, the better.

Some persons have confused hydrostatical pressure with the dynamical conditions incidental to motion. The hydrostatical pressure sustained by the sides of the rudder, if held at an angle, balance one another and are distinct from the reaction due to change of momentum in streams having motion relatively to the rudder. Without motion of a ship through the water or of the water past the rudder, it can have no steering power. The check put upon streams by the rudder must produce a reaction not merely upon the rudder itself, but upon the portion of the stern post or deadwood above the propeller aperture. This additional pressure on the deadwood will be delivered on the side toward which the rudder is put over it and must considerably assist the rudder in steering a steamer. When a rudder is placed at an angle with the keel line of a steamer and the streams of water impinge upon its surface, in consequence of the motion of the ship, or of the action of her propeller, the motion of these streams must be checked or diverted, and a change of momentum is produced which reacts upon the rudder and causes a normal pressure upon its surface and also upon the deadwood of the screw aperture (except when the aperture is open at the top).

The large aperture or vacant space before the rudder, in which the screw is working, must also divert and disturb the symmetry of the stream lines and cause eddies and broken water to impinge on the rudder, thus causing the steering of the ship to be irregular and comparatively slow, or as sailors say, it causes the ship to steer wildly.

For regular and quick steering, the smaller the screw aperture the better. The upper surface of the rudder is not more effective than the lower surface when the water flows uninterruptedly to the rudder over its total immersed depth, as in a sailing vessel, but in a screw steamer nearly the whole of the immersed surface of the rudder, when the vessel is still, meets with broken water and irregular eddies when she is at sea, if the screw aperture be large and open for a considerable height above the top of the propeller blades, but when this aperture is reduced in breadth and closed in immediately above the screw propeller, the upper surface of the rudder then becomes much more efficient than the lower surface, because the stream lines of the water in motion flow symmetrically on until they come into actual impact with the rudder, and in consequence the impulse of the water acts directly and uniformly on either side over the upper surface of the rudder, according to the direction in which it is turned; hence, it appears that the upper surface is more effective than the lower surface, which is directly affected by the screw propeller.

BALANCED RUDDERS.

By a balanced rudder I mean a rudder having a portion of its surface (usually about one third) before the axis about which it rotates. Such rudders are not uncommon on these lakes, indeed they may be said to be the common type of rudder on the inland seas; but notwithstanding the fact that such rudders are more efficient, as I shall presently demonstrate, they have occasionally and even recently been superseded by the common tramp type of rudder and by a modification of that rudder.

Mr. White tells us that the balanced type of rudder has been long known; Earl Stanhope proposed its adoption in 1790, and Captain Shuldham fitted one to a ship about seventy years ago. It was also fitted in the Great Britain in 1845 and it has been frequently fitted to government ships during the last thirty years. Various rules have been used for determining the areas of rudders for steamers. For lake vessels having lengths from seven to eight times the beam, the immersed surface of the rudder should equal to about one-fiftieth of the immersed middle line longitudinal section of the ship, the extreme breadth being not greater than one-sixth of the breadth of the beam plus 1 foot. This is a slight modification of Mr. Scott Russell's rule.

Mr. Macrow says: Four features chiefly affect the readiness of a ship to answer helm: 1, time occupied in putting helm hard over; 2, rudder pressure corresponding to that position; 3, moment of inertia of ship about vertical axis passing through the center of gravity; 4, moment of resistance to rotation.

The diameter of circle turned in has been found to vary between six and eight times the length of the ship with ordinary rudders and from four to five times with balanced rudders, using manual power only. With steam power the circle turned in with ordinary rudders about four times the length of the ship, and with balanced rudders less than three times the length.

Rudder areas may be proportioned as follows: A^1 and A^2 = middle line planes of two similar ships, a^1 and a^2 the rudder areas, l^1 and l^2 the lengths; then

$$\frac{a^1}{a^2} = \frac{A^1}{A^2} = \left\{\frac{l^1}{l^2}\right\}^2$$

As an example, suppose a lake steamer 300 feet long and 16 feet mean draught of water has a rudder surface of 100 square feet, the middle line plane being 4,800 square feet. Then for a steamer 400 by 20 feet draught, having a middle line plane equal to 8,000 square feet, the rudder area would be as follows:

$$\frac{A}{100} = \frac{8{,}000}{4{,}800} = \left\{\frac{400}{300}\right\}^2$$

by which we see that the area for the large steamer would be 296·3 square feet. This simple and accurate formula for ocean steamers does not conform to our lake practice, indeed it is just as far in excess of the surface provided by our best shipbuilders as the diameter of rudder heads corresponding to the handbook formula, for high speed ocean steamers, is in excess of the diameter found to be sufficient for high power lake steamers.

Let me now say a few words about the turning of steamships and the efficiency of balanced rudders.

Professor Rankine, when investigating the point of the instantaneous axis about which a ship should begin to turn when the rudder was first put over, regarded the first action of the rudder as an impulse, and experienced seamen declare that when a steamer has headway and the helm is put over, the head turns comparatively slowly, while the stern swerves suddenly to the right or the left.

As an example of the superiority of balanced rudders, consider the trials of the Minotaur and Bellerophon. The Minotaur, with eighteen men at the wheels and sixty at the relieving tackles, turned a circle in 7¾ minutes, 1½ minutes being occupied in putting the helm over to the very moderate angle of 23 degrees. The Bellerophon had a balanced rudder with 25 per cent. greater area than that of the Minotaur, but it was put over at an angle of 37 degrees and in about twenty seconds by eight men when the ship was steaming at about the same speed the Minotaur had attained.

By means of either hydraulic or steam power the largest rudders can be worked and put hard over in a few seconds by one man or by the master himself when ships are moving at the highest speed.

It still remains true, however, that the adoption of the balanced rudders minimizes the work to be done in steering, and it has been proved repeatedly by experimental trials, that large high speed ships fitted with balanced rudders can be safely steered by hand, which could not be so steered with an ordinary rudder.—Marine Record.

NOTES ON ELECTRICITY.

By JOHN TUNBRIDGE.

THE nomenclature of the science is not significant. Many of the terms used may be admissible, as they suggest no explanation. The inherent quality of the science lacks confirmation. Hence the frequent interrogation: What are the attributes of electricity?

There is a vast amount of scientific research constantly directed toward the discovery of those laws that regulate chemical and physical actions. Modern methods of analysis have done great service. They have put us in possession of facts totally independent of all hypothesis. Many curious phenomena have met with solution by its aid. With this extended field of inductive research, it may suggest the proposition that there is some relation between known quantities and the question at issue, and that some rational hypothesis may be arrived at, with formulæ of sufficient value that may lead to future progress of electrical science. If the peculiar behavior of electrical phenomena furnishes sufficient evidence of the principles that govern its action, then there are a multitude of facts deducible from recent investigation that leaves little doubt as to the ultimate solution of this important question.

A few points may be referred to:

Professor William Crookes recalls the fact that high authorities could not agree whether we have one electricity or two opposite electricities, and that there is great probability that electricity is atomic, and that an electrical atom is a definite quantity, as is the chemical atom, etc. In Mr. Tesla's researches it appears that true flame could not be produced without chemical aid. It has been asserted that electricity is a kind of matter, or form of energy. Recent investigations, however, have put us in possession of facts bearing on this important subject.

In the examination of some of the elementary bodies the integrity of their individuality may be questioned. Some have quality differing greatly from the elements. This may be due to other effects not yet determined. Physical chemistry may offer a suggestive field of inquiry. The fact that motion is inherent to all matter is of great significance. An innate principle, or the action of matter on itself, the study of light, heat, and the phenomena of radiation, point that way.

If electricity is elementary, it has well masked its identity. By the assistance of that wonderful instrument, the spectroscope, much additional knowledge has been made known by recent researches of physical chemistry that leads to the hope that some definite solution of electrical phenomena may be explained, or furnish sufficient data for some rational hypothesis.

On these considerations we arrive at the following conclusion: That all manifestations of electrical phenomena are due to the presence of hydrogen as the active agent, consequently atomic. The great attraction that exists between oxygen, chlorine, carbon, etc., and their peculiar physical behavior under disposing influence or molecular disturbance, induces the belief that this element, hydrogen, carries with it some active principle or subtile quality not yet recognized. What is now called a form of energy may be traced to this peculiar feature.

The difference of gravity between nitrogen of the atmosphere and that element in its normal condition has already led to the knowledge of its compound nature. The many peculiar qualities of hydrogen distinguishes that element, and is highly characteristic.

Spectrum analysis of the heavenly bodies reveals immense quantity of hydrogen, and more recent research points out another element lighter than hydrogen, called ether, which must be observed always accompanies that body. A ray of light passes through an atmosphere of space whose frigidity is beyond human conception, then in contact with terrestrial atmosphere creating molecular disturbance, giving rise to the phenomena of light, heat and radiation; not dissimilar, perhaps, from the source by which it is derived. What is called a form of energy, or the vital connection of the unknown world, may be traced to that pro-hydrogen element above referred to.

Such a procedure of examination would explain many of the peculiar phenomena observed in chemical physics, the relative quantities of matter, and the disturbing influence of external circumstances, and would explain the two electricities above referred to. Also the electro-chemical decomposition and many singular features relating to kindred sciences. Lastly, if these views are correct, electricity could not be generated in a dry atmosphere, free from moisture or in vacuity.

Newark, N. J., 1895.

THE ELECTRIC PLOW IN GERMANY.*

By OTTO DOERDERLEIN United States Consul at Leipsic.

IN compliance with instructions received from the Department May 27, I have visited the factory of Messrs. Zimmermann & Company, manufacturers of the electric plow, and herewith submit a report on this new and useful invention.

Although steam plows, in conjunction with locomobiles, have in the last thirty years shown great advantages over manual and animal labor, several objections thereto are irremediable, notably (1) their cost, (2) the expense of fuel and attendance, (3) the necessary water supply, (4) their size and weight, and (5) their inapplicability to small farms, for the first four reasons, and small farms form an important part in this question of national economy.

Size and weight are serious elements, in view of the looseness of the soil under treatment.

Locomobiles, owing to their long periods of inaction during the year, waste an immense amount of motive power. Moreover, the rate of payment is, for such reason, very high.

Electromotors, on the other hand, are (1) far less expensive to make; (2) far lighter in their construction, and, consequently, more portable; (3) they can be used at a far greater distance from the actual source of power, thus saving much haulage.

A stationary engine or locomobile for farming on a large scale transfers its elementary power through an electromotor to the seesaw, tilting, or balance plow, the motor being mounted on the plow itself, thus avoiding wire rope traction. The anchor shaft of the motor sets in motion a double spur wheel, which, in turn, drives a pinioned shaft.

A chain extended over the field and held taut at both ends by triple ground anchors is worked by this pinioned shaft, which draws the plow along the chain across the field. On reaching the end of the chain, the plow is tilted to the other side and the simple reversal of the current sets the plow in motion in the opposite direction. In returning, it deposits the chain sideways ready for the next row of furrows. A laborer, by turning a lever, draws up the three ground anchors, and, by this simple action, sets the traveling wheels affixed to the anchor axles in motion, so that the anchors are easily moved to the next furrow. The motor tightens the chain before starting; the slack length of chain thus deposited behind the plow allows for any inequalities of length resulting from the shift-

ANCHOR.

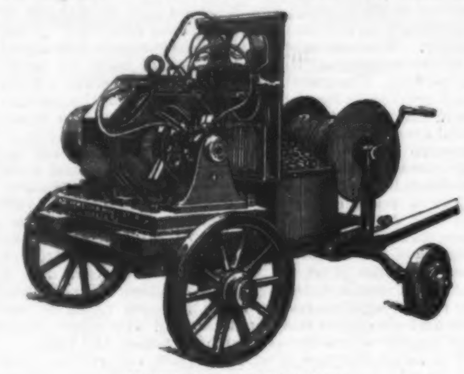
ing of the anchors, which are also provided with a spare length of loose chain for use in case of need.

THE ELECTRIC PLOW IN SMALL HUSBANDRY.

There are three factors to be considered, viz.: (1) the source of power, or primary station; (2) the transmission of such power; (3) the tilting plow, with its electromotor.

(1) The Source of Power.—This may be any ordinary agricultural locomobile of from 8 to 12 horse power, but special care must be taken to furnish it with as sensitive a regulator as possible, in order to be able to surmount the irregularities liable to occur in switching the electrometer on and off, and also to prevent the occurrence of too great fluctuations in the number of revolutions. The locomobile may stand on any solid ground at the edge of the field to be plowed. It drives the dynamo machine (electricity generator), which is placed on a car.

This car also serves to transport the gaging apparatus for measuring the strength of current and tension, a reel or windle for the cable, as well as for bringing the plow to the field. One end of the tipping plow is fastened behind this primary station car by means of a cramp iron, while the guiding roller in the rear is placed so far downward as to rest on the ground and thus guide the plow. Locomobile and primary station together are thus brought to the desired spot with one team. As soon as the locomobile is set up accurately



DYNAMO MACHINE.

by means of brake blocks, the dynamo car is placed straight before it, fastened into the ground by means of an anchor placed opposite to the belt tension; the driving belt is placed over the driving wheel of the locomobile and the disk of the pulley of the dynamo machine, and the primary station is then in working order. The dynamo machine and gaging apparatus are protected against the weather by means of a cover. As the primary station is overlooked by the fireman of the locomobile, the dynamo machine does not require a special attendant.

(2) The Transmission of Power.—Two cables, corresponding with the two poles, serve to transfer the electric power from the dynamo machine to the electromotor. One end of this pair of cables is affixed to a projecting bar of the plow and moves backward and forward with it, like a pendulum, while the other pair of ends is secured to the dynamo machine.

The friction of the cable on the ground is avoided by means of light cable carriages fitted with insulating nippers. These carriages follow each motion of the plow automatically, as the wheels are fitted into forks which, pivoting in every direction, answer to all the movements of the plow.

Five or six such cable carriages, according to the length of the area to be plowed, are easily watched by a boy, who has to take care that, in reversing the motion of the plow, they follow such motion.

(3) The Tilting Plow, with Electromotor.—A tilting plow for small husbandry is fitted with two shares on each side. In front of each of these is a forecutter to prepare the ground. The frame and body, as also all other parts of the plow, are of iron and steel, and so strongly made that it is powerful enough to cut furrows to the depth of from 25 to 28 centimeters (10 to 11 inches), even in heavy, clogging ground. The plow may also be fitted with underground looseners, which follow the plow, and loosen the subsoil to as much as 40 centimeters (15¾ inches) in depth, but do not turn it over.

The iron frame of the tipping plow bears in the center shaft an arrangement on which are two main wheels of different diameters; these are adjustable perpendicularly and turnable sideways. The adjusting or placing of the wheels is easily effected from the driver's seat by means of a spiral and wheel, so that the driver has the plow under thorough control. An electromotor is mounted on the plow frame. A spur wheel is wedged on to the motor's anchor shaft. The motion of the electromotor is transmitted from this spur wheel with the aid of an intermediate appliance to a roller with a chain wheel. The dimensions of this appliance, which is made of cast steel, are so determined that the compass of the chain wheel receives a lineal speed of 70 meters per minute. The plow is, therefore, moved at this rate of speed across the field by means of the stretched out chain, the links of which are 11 millimeters (seven-sixteenths of an inch) thick.

The chain is directed on to the chain wheel by guiding rollers in such manner that the tautly stretched chain end is constantly striving to raise the forward end of the plow as well as to press the rear end into the soil. This results in a steady and certain progression of the plow, enabling one with this implement to throw stubble from 10 to 15 centimeters (4 to 6 inches) in height flat down, and to cut seed ridges.

To this end, special peeling or shelling apparatus are constructed, which, after removal of the plowing arrangement, are affixed to the frame of the tipping plow in the simplest manner, the operation being easily performed in a short time by any plow driver.

The mode of proceeding to the next row of furrows and reversing the motion of the plow have already been explained.

THE ELECTRIC PLOW IN HUSBANDRY ON A LARGE SCALE.

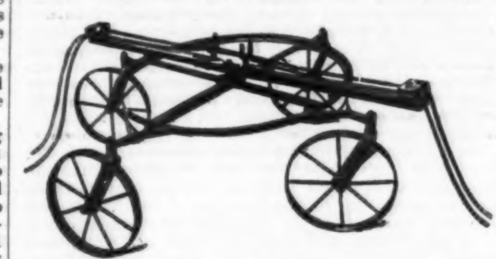
For extensive farming operations, the aim was to produce an electric plow capable of plowing 4 to 5 hectares (1 hectare=2·47 acres) to a depth of 35 centimeters (13¾ inches) in ten hours. As this requires about 35 horse power, the ordinary locomobiles at hand are not available. But, on the other hand, any ordinary stationary engine is capable of supplying the elementary power necessary to run the dynamo machine under specially advantageous conditions. In fact, a properly fitted stationary engine will always work more economically than a portable engine, which will frequently burn up to 10 kilogrammes (22·046 pounds) of coal per hour per square meter of heated surface. The expense of water carting is also dispensed with.

As in the case of small farming, the operation is comprised under three headings, viz: (1) the primary station, (2) the transmission of power, and (3) the plow, with electromotor.

(1) The Primary Station.—A dynamo machine of the requisite power is attached by driving belts to the stationary engine, being, of course, fitted with the necessary appliances for gaging the force of the current and the tension. Water power, where available in the necessary degree, may be very advantageously used to drive the dynamo machine, which can be done by either taking the power direct from the turbine or the water wheel or by indirect beltings.

Here, again, it is essential that the elementary machine be prevented, by the introduction of suitable regulators, from too much variation in its revolutions.

In like manner, when land is being reclaimed or improved, the stationary power must be used rationally. Thus, instead of the driving machinery of the pumping works, a dynamo machine should be used to produce the electricity, which can be conducted thence to any desired distance and for any wished-for purpose. It is only in such manner that a stationary en-



CABLE CAR.

gine can be intelligently turned to account in husbandry, inasmuch as uninterrupted use materially reduces the cost of creating steam, both per hour and per horse power. Moreover, as the electric current is available, the electric plow may, with the aid of electric light, be worked all night.

(2) Transmission of Power.—Two bare copper wires are carried from the dynamo machine to the field which is to be plowed, in like manner as telegraph wires are borne, namely, on poles. According to the size of the field, this connection by copper wire is either brought to the further end of the field, or where its length is 800 to 1,000 meters (2,625 to 3,281 feet), to the center division line of the field's length. Both the cables are affixed to the copper wires by nippers in such a way that they can be easily moved backward or forward. These cables are borne by the cable carriages and move forward and backward with the plow like a pendulum.

(3) The Plow, with Electromotor.—A three or a four share plow is used for husbandry on a large scale. It is made on the same principle as the two-share implement, already described, only proportionately stouter. The frame of the tipping plow, which carries the cast steel plowing contrivance, as its dimensions, etc., necessitate, is made of strong iron and carries a proportionately powerful electromotor; this, by means of an intermediate wheel gear, sets a chain wheel in motion, which, in turn, draws the plow along the chain stretched across the field. Both the chain and its ground anchors are like those used with the two-share plow, only corresponding in power to the demands made upon them. These anchors require two men to turn them. One of them may be the plow driver, while another man is stationed at each anchor to help in tipping the plow and shifting the anchor.

The reversing and resistance gear is easily handled from both of the driving seats, so that the driver, while guiding the plow with ease, has at the same time control of its motions. The depth of the furrows is determined by adjustable rollers. The transport of this tipping plow to the field is effected in exactly the same manner as already described.

WORKING EXPENSES OF THE ELECTRIC TILTING PLOW.

(1) Two-share Plow in Small Farming.—The experiments were made on heavy, binding, loamy clay soil near Halle-on-the-Saale. A ten horse power locomobile, fitted with a very exact regulator, was used, with the following result:

Gages showed a current tension of 110 volts and a current force of 60 to 80 amperes, an average of 8,000

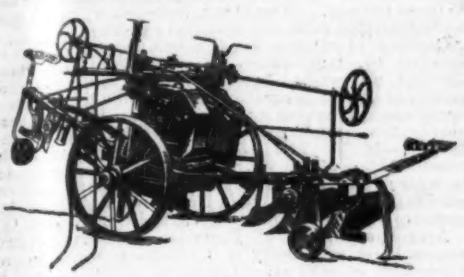
THE ELECTRIC PLOW IN SMALL FARMING

* From Consular Reports to the State Department.

volt amperes (watt), this being equal to the capacity of the locomobile up to eleven horse power. Two furrows 60 centimeters broad by 24 centimeters deep (23⅝ by 9⅘ inches) at each plowing. Power gage varied between 600 and 700 kilogrammes (1,344 and 1,568 pounds), giving a mean of 650 kilogrammes (1,456 pounds) a resistance of from 45 to 48 kilogrammes (100·8 to 107⅖ pounds) per square decimeter (3·937 inches) of the cross section of a furrow.

At a progression of 0·9 meter per second, 7·8 horse power was made really useful, so that the loss of power between locomobile (11 electric horse power) and plowing (7·8 horse power), arising from transmission of power and tooth and chain friction, was 3·2 horse power. Compared with the loss shown by steam plows, this is exceedingly small.

Ignoring the purchase money for the locomobile, as



TWO-SHARE PLOW.

most farms have one for thrashing purposes, the cost of working was:

	Marks.
1 fireman, ten hours	3·50
1 driver, ten hours	3·50
2 boys, ten hours	3·00
Interest and sinking fund for working capital and repairs, excluding electromotor, on 6,750 marks, 20 per cent. per 100 days	13·50
On 1,750 marks (motor complete), 15 per cent. per 100 days	2·62
On chain, 50 per cent on 480 marks, 100 days.	2·40
Fuel, 400 kilogrammes at 2·25 marks	9·00
Lubrication of locomobile, dynamo machine, electromotor and plow	2·00
Two loads of water	4·00
Total	43·52

With 8 acres in ten hours, on heavy soil, with a depth of 24 centimeters (9·24 inches), the cost would be 5·44 marks ($1 29) per acre, against 12 marks ($2.74), the cost of doing the work with oxen. In comparing with the cost of the latter, even with a depth of furrow of from 30 to 35 centimeters (11·8 to 13·8 inches), the electric plow is still by far the cheaper.

One boy drilled to the work would suffice.

In many positions the locomobile could feed the boiler from an automatic pump. These two items would reduce the daily cost by 5·50 marks ($1.31), bringing it down to 4·80 marks ($1.14) per acre.

The economy effected is so self-evident as to render argument superfluous.

(2) In Large Farming.—A comparison with the steam plow is necessary in order to make the following statistics intelligible:

The cost of steam plowing to a depth of 35 centimeters (13·8 inches), evidently with variety in character of soil, is stated by two German authorities at 39·36 marks ($9.37) and 46·72 marks ($11.12), respectively, per hectare (2·47 acres), whereas both give the cost of plowing with oxen at 50 marks ($11.90) per hectare. And, moreover, a steam plow costs 60,000 marks ($14,280), as capital to be provided for.

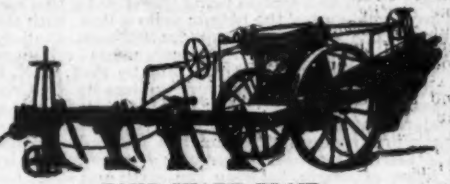
As against this, the large electric plow shows: (1) Cost of stationary steam engine (semilocomobile), complete, 40 to 45 horse power, 13,000 marks ($3,094); (2) dynamo machine, including foundations and driving belts to produce 33,000 watts per hour, together with the necessary gages, 5,000 marks ($1,190); (3) electric conduits, complete, including labor, etc., 3 kilometers (1·86 miles) in length (in many districts poles would be cheaper), 4,500 marks ($1,190). Making the expenses (sinking fund, interest, wages, coal, etc.) 34·94 marks per day of 10 hours, or 3·494 marks (83 cents) per hour for 3,300 watts, not including transmission loss, which brings the cost up to 11·7 pfennigs (2·8 cents) per 100 watts.

The results hitherto obtained show that, with a motive power of 33,000 watts, it may be guaranteed that 4 square hectares can be plowed 35 centimeters deep in ten hours. This would show:

		Marks.
30. × 11,7010.		35·10
Wages, two hands		10·00
Sinking fund, interest, and repairs, 20 per cent. on the fitting up of the complete plowing gear, without the chain, capital sum 10,300 marks	2,060·00	
Chain, 50 per cent. on 830 marks, its cost	415·00	
Total	2,475·00	
Taking an average of 100 working days of 10 hours per annum this would show, per day		24·75
Total cost per day		69·85

Or, in round figures—4 hectares in ten hours—per day, 70 marks.

It is thus evident that the working expenses of the electric plow for extensive husbandry amount to less than half of those incurred in working the steam plow.



FOUR-SHARE PLOW.

This contrast is readily explained, for (1) the capital sunk in plant is only one-third of that required for the steam plow; (2) the expenses connected with the generating of power are materially lower than is the case with the steam plow, in which a very considerable surplus power has to be raised in order to work the pulleys and brakes and to overcome the stiffness of the rope; (3) the expensive transport of water is herein entirely done away with.

I have been informed by the director of the Halle factory that electricity will shortly also be used in digging out potatoes and sugar beets.

OTTO DOEDERLEIN,
Consul.

Leipsic, July 15, 1895.

FACTS ABOUT LIGHTNING.

THE striking of the Washington Monument by lightning during a recent thunder storm is not the first time that that structure has suffered from lightning stroke. The wonder is that it has not more frequently attracted atmospheric electricity on its passage from cloud to earth, for, standing as it does 555 feet high, in the center of flat, well-watered ground, it constitutes a most dangerous exposure for lightning flashes. The immense shaft is protected by an elaborate and seemingly effective system of lightning conductors. This system was begun in January, 1880, and completed in January, 1885, the date of the practical completion of the monument.

The conductors consist of the four hollow wrought iron Phœnix columns supporting the elevator machinery. The bottoms of these four columns rest upon and are bolted to cast iron shoes standing upon the floor of the large drum pit, the shoes being connected to ⅜ inch soft copper rods led to the bottom of a well in the center of the foundation. This well is 32 feet 10 inches deep below the bottom of the drumpit, and 15 feet 8 inches below the bottom of the masonry foundation, and the water stands in it permanently 2 feet 8 inches above its bottom. After the copper rods were inserted the well was filled up with clean, sharp sand for 15 feet 8 inches, or up to the level of the bottom of the old rubble stone foundation of the monument. These four columns, so arranged at their bases, and always projecting above the top of the shaft or monument, were lengthened as the building of the monument progressed, and acted as the lightning conductors of the edifice during the five summers the masonry work was in progress. In that period no disruptive discharge of electricity was experienced. When the marble pyramidion was completed, December, 1884, these four columns were within the marble covering, and from the extremity of each column a copper rod three quarters of an inch in diameter was run to the top stone, and there united in a copper rod 1½ inches in thickness, which passed vertically through the cap stone and was screwed into the solid aluminum pyramid.

This system was entirely completed and connected on January 20, 1885. It was, of course, believed that it would afford immunity to the great shaft, then the highest edifice in the world, from lightning stroke. It was not long, however, before those who were in charge of the structure were rudely awakened from their fancied security. On June 5, 1885, less than six months after the completion of this system of lightning protection, during a heavy thunder storm, the monument was struck. Upon examination a crack was discovered in the stone on the north face of the pyramidion just under the top stone, extending through the block in a line nearly parallel to the northeast corner and about 8½ inches from it. The fragment was pressed outward about three-fourths of an inch at its bottom, chipping a small piece off the lower corner of the top stone into which it was locked, and was easily forced back into place and bolted to the solid stone from which it had been torn.

Col. Casey, of the Army Engineer Corps, who was in charge of the construction of the monument, requested Profs. Rowland, Newcomb and Mendenhall to examine the part struck and suggest what precautions should be taken to insure the safety of the monument. They recommended that the interior conductors be connected with a system of rods and a greater number of points, to be located upon the exterior of the pyramidion. Accordingly four half inch copper rods were fastened by a band to the aluminum terminal and led down the corners to the base of the pyramidion, and then through the masonry to the columns of the elevator. These exterior rods are each over sixty feet long, and are also connected at two intermediate points of their length with the iron columns by means of copper rods ⅜ and ¾ inch in diameter, respectively, furnishing sixteen rods in all, connecting the exterior system of conductors with the interior conducting columns. Where the exterior conducting rods upon the corners cross the eleven highest horizontal joints of the masonry of the pyramidion they are connected to each other all around by other copper rods sunk into these joints. All of these exterior rods, couplings, and fittings are gold plated, and are studded at every five feet of their lengths with copper points three inches in length, gold plated and tipped with platinum. There are two hundred of these points in all.

Apparently this elaborate system of protection saved the monument from injury from the recent disruptive discharge of electricity or "impulsive rush," as Dr. Oliver Lodge, the latest and most exhaustive experimenter with lightning, calls it. Yet his experiments demonstrate that the last word has not yet been spoken as to lightning and lightning rods as protectors. While Dr. Lodge says that lightning rods "are essential to anything like security," he qualifies it by saying that "almost any conductor is probably better than none, but few or no conductors are absolute and complete safeguards." Sir William Thomson can say no more in their favor than that there is "very strong reason to feel that there is a very comfortable degree of security, if not of absolute safety, given to us by lightning conductors made according to the present and orthodox rules." And Prof. McAdie, of the Weather Bureau, can only say that "beyond doubt, Franklin proved that lightning rods were efficacious in the protection of buildings."

The work of gathering statistics of the loss of life and property from lightning has never been done with the care and comprehensiveness that seem to be demanded. The Weather Bureau began in 1890 to keep a record of deaths from lightning. For the four years 1890–1893 these numbered 784, an average of 196 a year. Prior to this the only known record of this kind in the United States was kept by Mr. H. F. Kretzer, of St. Louis, Mo., his sources of information being 192 newspapers, daily, weekly and monthly. He found that for the five years 1883–1887 there were 1,030 deaths caused by lightning, an average of 206. So far as the records show, and there are no returns at all from several States, there were in the United States in the eight years ending 1892, 3,516 fires caused by lightning, and entailing a loss of $12,663,835, or an average of more than 400 a year, with a yearly loss exceeding $1,500,000. Of the buildings struck there were 2,335 barns, 664 dwellings and 104 churches.

According to Prof. McAdie, the risk of lightning stroke is five times greater in the country than in the city, because ordinary dwelling houses in city blocks receive a very considerable protection from the tin roofing, cornices, gutters and so on. The Royal Prussian Bureau of Statistics says that the geological formation of the ground has some influence upon the frequency of lightning strokes. Thus, if 1 represents its frequency in a chalk formation, 2 will represent it in marl, 7 in clay, 9 in sand and 22 in loam.

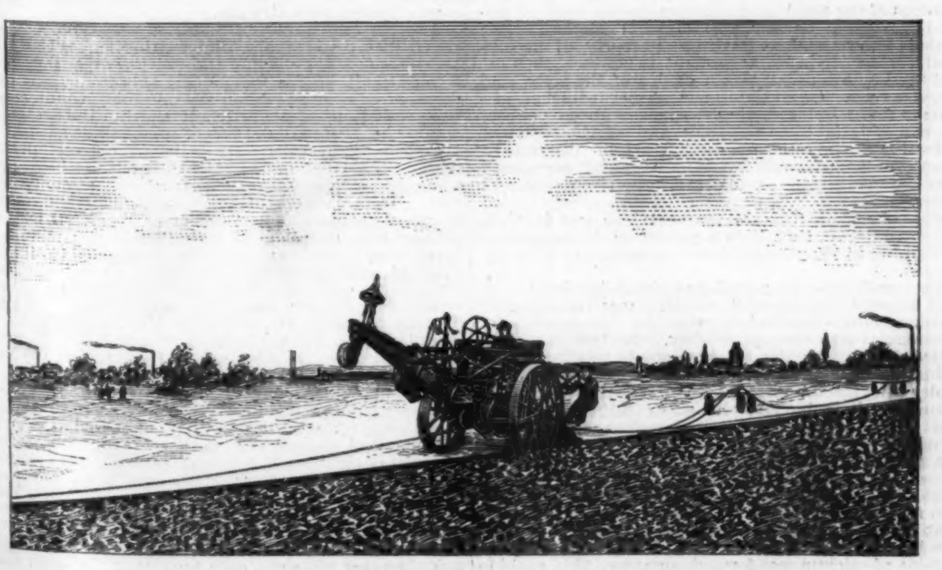
Another curious thing about lightning is that, with all its disposition to strike trees, it has, in a blind sort of way of its own, a preference between varieties. This singular fact was observed more than a hundred years ago, when it was announced in general terms that the elm, chestnut, oak and pine were often struck, the ash rarely and the beech, birch and maple never. Further observation showed that the last statement is not true. It is a fact, however, that the oak is most frequently and the beech the least frequently struck.

The values are something like, if 1 represents the frequency for the beech tree and 15 for pines, other trees generally averaged at 40, and the oaks at 54.

Trees struck are generally those standing in the clear or on the edge of forests, and in height from 52 to 66 feet. The trunk appears to be struck about three times as often as the boughs. The stroke usually travels to the ground, only jumping to other trees about three times in a hundred.

It is dangerous to stand under trees, in the doorways of barns, close to cattle, or near chimneys and fireplaces during thunder storms. On the other hand, no safety is gained by going to bed or trying to insulate oneself in feather beds. Small articles of iron or steel do not have the power to attract lightning or determine the path of discharge. Nor will a few inches of glass or a few feet of air serve as a competent insulator to bar the progress of a flash of lightning that has forced its way through a thousand feet of air.

There are no competent records which show what



THE ELECTRIC PLOW IN LARGE FARMING.

proportion of persons struck by lightning are killed outright. Prof. McAdie says he knows of but one record, and in that of 212 persons struck, 74 were killed. Therefore, he urges that where a person has been struck by lightning the effort to stimulate the respiration and circulation should not cease in less than an hour's time. He believes that lightning often brings about suspended animation rather than somatic death, and says there are a number of cases in the medical journals corroborative of this view.—N. Y. Sun.

RECENT DISCOVERIES OF GASEOUS ELEMENTS.*

THE past year has been such an eventful one in the way of startling discoveries that I must ask indulgence for trespassing a little further upon the time of the section. It was only last year at the Oxford meeting of the British Association that Lord Rayleigh and Prof. Ramsay announced the discovery of a gaseous constituent of the atmosphere which had up to that time escaped detection. The complete justification of that announcement is now before the world in the paper recently published in the Philosophical Transactions of the Royal Society. The history of this brilliant piece of work is too recent to require much recapitulation. I need only remind you how, as the result of many years' patient determinations of the density of the gases oxygen and nitrogen, Lord Rayleigh established the fact that atmospheric nitrogen was heavier than nitrogen from chemical sources, and was then led to suspect the existence of a heavier gas in the atmosphere. He set to work to isolate this substance, and succeeded in doing so by the method of Cavendish. In the meantime Prof. Ramsay, quite independently, isolated the gas by removing the nitrogen by means of red hot magnesium, and the two investigators, then combining their labors, followed up the subject, and have given us a memoir which will go down to posterity among the greatest achievements of an age renowned for its scientific activity.

The case in favor of argon being an element seems to be now settled by the discovery that the molecule of the gas is monatomic, as well as by the distinctness of its electric spark spectrum. The suggestion put forward soon after the discovery was announced that the gas was an oxide of nitrogen must have been made in complete ignorance of the methods by which it was prepared. The possibility of its being N_3 has been considered by the discoverers and rejected on very good grounds. Moreover, Peratoner and Oddo have been recently making some experiments in the laboratory of the University of Palermo with the object of examining the products of the electrolysis of hydrazoic acid and its salts. They obtained only ordinary nitrogen, not argon, and have come to the conclusion that the anhydride $N_3.N_3$ is incapable of existence, and that no allotropic form of nitrogen is given off. It has been urged that the physical evidence in support of the monatomic nature of the argon molecule, viz., the ratio of the specific heats, is capable of another interpretation—that argon is, in fact, an element of such extraordinary energy that its atoms cannot be separated, but are bound together as a rigid system which transmits the vibrational energy of a sound wave as motion of translation only. If this be the state of affairs, we must look to the physicists for more light. So far as chemistry is concerned this conception introduces an entirely new set of ideas and raises the question of the monatomic character of the mercury molecule which is in the same category with respect to the physical evidence. It seems unreasonable to invoke a special power of atomic linkage to explain the monatomic character of argon, and to refuse such a power in the case of other monatomic molecules like mercury or cadmium.

The chemical inertness of argon has been referred also to this same power of self-combination of its atoms. If this explanation be adopted, it carries with it the admission that those elements of which the atoms composing the molecule are the more easily dissociated should be the more chemically active. The reverse appears to be the case if we bear in mind Victor Meyer's researches on the dissociation of the halogens, which prove that under the influence of heat the least active element, iodine, is the most easily dissociated. On the whole, the attempts to make out that argon is polyatomic by such forced hypotheses cannot at present be considered to have been successful, and the contention of the discoverers that its molecule is monatomic must be accepted as established.

In searching for a natural source of combined argon Prof. Ramsay was led to examine the gases contained in certain uranium and other minerals, and by steps which are now well known he has been able to isolate helium, a gas which was discovered by means of the spectroscope in the solar chromosphere during the eclipse of 1868, by Profs. Norman Lockyer and E. Frankland. In his address to the British Association in 1872 (Reports, 1872, p. lxxiv) the late Dr. W. B Carpenter said:

"But when Frankland and Lockyer, seeing in the spectrum of the yellow solar prominences a certain bright line not indentifiable with that of any known terrestrial flame, attribute this to a hypothetical new substance which they propose to call helium, it is obvious that their assumption rests on a far less secure foundation, until it shall have received that verification which, in the case of Mr. Crookes' researches on thallium, was afforded by the actual discovery of the new metal, whose presence had been indicated to him by a line in the spectrum not attributable to any substance then known."

It must be as gratifying to Profs. Lockyer and Frankland as it is to the chemical world at large to know that helium may now be removed from the category of solar myths and enrolled among the elements of terrestrial matter. The sources, mode of isolation and properties of this gas have been described in the papers recently published by Prof. Ramsay and his colleagues. Not the least interesting fact is the occurrence of helium and argon in meteoric iron from Virginia, as announced by Prof. Ramsay in July (Nature, vol. lii, p. 224). Like argon, helium is monatomic and chemically inert, so far as the present evidence goes. The conditions under which this element exists in clèveite, uraninite and the other minerals have yet to be determined.

Taking a general survey of the results thus far obtained, it seems that two representatives of a new group of monatomic elements characterized by chemical inertness have been brought to light. Their inertness obviously interposes great difficulties in the way of their further study from the chemical side; the future development of our knowledge of these elements may be looked for from the physicist and spectroscopist. Prof. Ramsay has not yet succeeded in effecting a combination between argon or helium and any of the other chemical elements. M. Moissan finds that fluorine is without action on argon. M. Berthelot claims to have brought about a combination of argon with carbon disulphide and mercury and with "the elements of benzine, . . . with the help of mercury," under the influence of the silent electric discharge. Some experiments which I made last spring with Mr. R. J. Strutt with argon and moist acetylene submitted to the electric discharge, both silent and disruptive, gave very little hope of a combination between argon and carbon being possible by this means. The coincidence of the helium yellow line with the D_3 line of the solar chromosphere has been challenged, but the recent accurate measurements of the wave length of the chromospheric line by Prof. G. E. Hale and of the line of terrestrial helium by Mr. Crookes leave no doubt as to their identity. Both the solar and terrestrial lines have now been shown to be double. The isolation of helium has not only furnished another link proving community of matter, and by inference of origin, between the earth and sun, but an extension of the work by Prof. Norman Lockyer, M. Deslandres, and Mr. Crookes has resulted in the most interesting discovery that a large number of the lines in the chromospheric spectrum, as well as in certain stellar spectra, which had up to the present time found no counterparts in the spectra of terrestrial elements, can now be accounted for by the spectra of gases contained with helium in these rare minerals. The question now confronts us, Are these gases members of the same monatomic inert group as argon and helium? Whether and by what mechanism a monatomic gas can give a complicated spectrum is a physical question of supreme interest to chemists, and I hope that a discussion of this subject with our colleagues of Section A will be held during the present meeting. That mercury is capable under different conditions of giving a series of highly complex spectra can be seen from the memoir by J. M. Eder and E. Valenta, presented to the Imperial Academy of Sciences, of Vienna, in July, 1894.

With respect to the position of argon and helium in the periodic system of chemical elements, it is, as Prof. Ramsay points out, premature to speculate until we are quite sure that these gases are homogeneous. It is possible that they may be mixtures of monatomic gases, and, in fact, the spectroscope has already given an indication that they contain some constituent in common. The question whether these gases are mixtures or not presses for an immediate answer. I will venture to suggest that an attack should be made by the method of diffusion. If argon or helium were allowed to diffuse fractionally through a long porous plug into an exhausted vessel, there might be some separation into gases of different densities and showing modifications in their spectra on the assumption that we are dealing with mixtures composed of molecules of different weights.

* From the address to the chemical section of the British Association, Ipswich, 1895. By Prof. Raphael Meldola, F.R.S., F.I.C., For. Sec. C.S., President of the Section.

ACETYLENE GAS—ITS PROPERTIES AND ITS COMMERCIAL VALUE.

AN exhibition and test of acetylene gas was given in the Board of Trade room in Scranton, Pa., on the evening of September 5, by the following gentlemen, who represent the Acetylene Light, Heat and Power Company, of Philadelphia, Pa.: Joseph A. Vincent, Edward C Naphey, C. C. Adams, F. N. Lewis and Samuel L. Kent.

Through the kindness of the Board of Trade, the exhibition rooms were thrown open to those of the public who are interested in the new artificial light.

After the gentlemen from Philadelphia were introduced to the audience by Mr. D. M. Atherton, the secretary of the Board of Trade, Mr. Vincent proceeded to explain the properties of acetylene gas, and calcium carbide from which it is obtained, substantially as follows:

It is a well known fact that carbon will combine directly with various metals under the influence of heat, and the resulting compounds are called carbides. The carbides of the alkali and alkaline earths, such as potassium, sodium, barium, stronium and calcium, whose oxide is known as lime, have the property of decomposing water upon being brought in contact with it, and thereby forming hydrate oxides of the metal and acetylene gas. Of all these carbides, carbide of calcium is the most interesting, because of the low cost of the raw material (lime and coal) and of the commercial value of the residuum or by product (hydrate of lime) which is formed by the subsequent decomposition of the carbide of calcium upon contact with water.

The chemical formula for acetylene gas is C_2H_2 which indicates that it is a saturated hydrocarbon, containing in 100 parts, 92·3 parts of carbon to 7·7 of hydrogen.

That such a gas as acetylene existed has long been well known to the scientific world, but it remained for accidental discovery to learn that its preparation for commercial uses was a possibility. In 1888, Mr. T. L. Wilson began a series of experiments relating to the reduction of the refractory metallic oxides by carbon under the intense heat of an electrical furnace, and found that lime, baryta, etc., when subjected to this heat were liquefied and formed molten masses which could be brought to ebullition.

An addition of carbon caused decomposition of the oxides, carbon monoxide being formed and driven off while the fused metal instantly with the excess of carbon formed a carbide. Further experiments showed that when a mixture of powdered lime and coke dust was introduced to the furnace, a sirupy mass of pure carbide of calcium was formed, also that this carbide became upon cooling, a dense, crystalline dark brown substance with a metallic fracture of blue or brown, and having a specific gravity of 2·62, and chemical composition represented by the formula $Ca\,C_2$, viz., 62·5 calcium, 37·5 carbon, which evolves a peculiar garlicky odor when exposed to a damp atmosphere, but is odorless in dry. When lumps of it were long exposed to the air the surface absorbed sufficient moisture to become changed to hydrate of lime, a thin layer of which protected the interior from subsequent decomposition.

Carbide of calcium is now being manufactured at Spray, N. C., at a cost of about $20 per ton. Experiments have demonstrated that 87½ lb. of lime and 56¼ lb. of carbon will produce 100 lb. of carbide of calcium and 43¾ lb. of carbon monoxide; and 100 lb. of carbide of calcium with 56¼ lb. of water will produce 115·62 lb. of slaked lime and 40·62 lb. of acetylene. The carbon monoxide is equal to 18¾ lb. of carbon and 25 lb. of oxygen. The above formulas will give some understanding as to the chemical reaction.

Carbide of calcium is not inflammable, and can be exposed to a temperature of a blast furnace without melting, but when placed in water or its vapors, each pound of it will generate over 5½ cubic feet (5·892) of acetylene gas, having a temperature of 64° F. It may also be decomposed by exposure to snow at a temperature of —24° F. The gas is colorless, but makes its presence known by a strong garlicky odor. It is soluble in water equal to the volume of the latter, and can readily be condensed to a liquid form at much less pressure than is required for carbonic acid gas ($C\,O_2$).

Acetylene gas at 67 27° F. requires a pressure of 39·76 atmospheres to solidify it. Carbonic acid gas requires a pressure of 58·84 atmospheres to solidify it, and as this represents the difference between 600 lb. and 900 lb. to the square inch, it may readily be seen that it has an important bearing upon the question of safety in handling and use. The carbonic acid gas tubes require a sustaining pressure 50 per cent. greater than is necessary for acetylene.

Acetylene gas when subjected to sufficient pressure becomes a colorless mobile liquid, and as the pressure is slightly relieved it commences to boil and evolve a gas which, upon ignition, burns with an intensely white flame, but if suddenly liberated would instantly solidify and form into a snow having a temperature of —118° F., and at this low temperature it possesses the same illuminating power as at the higher temperatures. The liquid gas is manufactured commercially by decomposing the carbide with water in a closed vessel, conducting the gas under pressure to a condenser, where it is liquefied and then drawn into tanks for distribution.

One pound of the liquid when evaporated at 64° F. will produce 14½ cubic ft. of gas at atmospheric pressure, or a volume 400 times larger than that of the liquid. In ordinary service conditions the gas is not affected by the temperature, as it can be cooled to 100° F. below zero or heated o 600° F. above, without impairing its illuminating power.

As an illuminant acetylene possesses lighting power and economy superior to any other illuminant known. When burned at the rate of but 5 cubic ft. per hour, its light is equivalent to 250 candles, and as good common gas is rated at about 20 candle power, it will produce 12½ times more light for the same quantity of gas. It has therefore 12½ times the value of illuminating gas.

Assuming $20 as a cost to manufacture one ton of carbide of calcium, which will produce 10,000 cubic ft. of acetylene gas, with a candle power of 50 candles per cubic foot, this would place the cost of the gas at $2 per 1,000 cubic ft. of 50,000 candles; $1 would therefore produce 25,000 candles. With good coal gas at $1 per 1,000 cubic ft., we get about 20 candles for each 5 cubic ft. burned; therefore, 1 cubic ft. produces 4 candle power, and 1,000 cubic ft. 4,000 candle power; as $1 produces in acetylene gas 25,000 candle power, it would be necessary to sell city gas at 16c. per 1,000 cubic ft. in order to compete with acetylene gas on this basis.

As there is less gas used, the oxygen of the air is not required to so large an extent in its combustion, and it is demonstrated that the air of a room lighted by this gas is vitiated at the rate of only ⅛ that of ordinary gas. The brilliancy of the acetylene flame would suggest the highest incandescence, but from actual test it is much cooler than that of an ordinary gas flame. The temperature of an ordinary gas flame is about 1,400° C. but no part of an acetylene flame is higher than 900° C. In fact there is very little difference between the heat of an incandescent electric light and acetylene based upon the same illuminating power. It is apparent from this that in rooms where acetylene gas is used there will be less danger of overheating, and the products of combustion will not be so noxious as in rooms lighted with city gas.

Another very important point in acetylene, as compared with the ordinary illuminating gas, is that the amount of carbon dioxide and water vapor produced is very small. A five foot burner of ordinary gas produces an amount of carbon dioxide that would equal the exhalations of about 18 adults, while the acetylene would equal the exhalations of about three adults.

To sum up, acetylene gas is easily detected by its odor. It gives more light, throws out less heat, consumes less oxygen and can be produced at much less cost. It is capable of being stored as a solid, in the shape of carbide, as a liquid or as a gas. It may be shipped long distances as carbide or as gas manufactured from it, and as a liquid may be applied to all purposes of isolated lighting, especially as in railroads, street cars, carriages, bicycles, steamships or sailing vessels, street lighting and individual houses, or it may be used to enrich the gas in the city houses, stores or manufactories, its application for the latter purpose permitting the manufacture of a gas sufficiently low priced to be used for heating or fuel purposes.

With all these facts in view it requires no gift of prophecy to foretell the early substitution of acetylene for all other forms of illuminating gas as well as electric lighting, and while it will work a revolution in the methods of lighting, it is bound, from its very simplicity, safety, effectiveness and low cost, to work as well a great revolution in all manufacturing processes. The city or town which can supply its street lamp from the tank concealed in its post will not be slow in doing away with costly mains and connections. The small manufacturer will soon learn the utility of cleaner and cheaper gas fuel. The suburban resident may discard his dangerous oil or gasoline apparatus, and the

city householder may laugh at gas corporations' extortions when he divorces his house from the meter and stores his six months' gas supply in his cellar closet.—Colliery Engineer.

[FROM THE INDEPENDENT.]

REMARKABLE SURGICAL OPERATIONS IN RECENT YEARS.

By GEORGE J. MANSON.

THE wonderful progress made in modern surgery cannot be better illustrated, at least to the mind of the layman, than by a reference to some of the remarkable surgical operations that have been performed in recent years.

Since the introduction of the antiseptic method, which prevents inflammation and suppuration, the surgeon's knife can be used on nearly every portion of the human body. This method aims to prevent harm coming to the patient after the operation has been performed through "surgical dirt," which is only another name for microbes. Scientists estimate that forty billions of such microbes will weigh less than a grain, and yet one microbe, under proper conditions, will so increase that in three days the product will weigh eight hundred tons.

It is only of late years that surgeons have operated on the brain. They can now remove a pistol ball from the brain where, as in some cases, it has lodged without fatal results, and send the patient about his business in less than two weeks' time. A quarryman, by the premature explosion of a blast, had a drill driven through his head, piercing his brain through and through. A successful surgical operation was performed upon him.

Some surgical operations on the brain result in increasing the intelligence of the patient. An eminent expert in brain surgery in this country (Dr. Kean, of Philadelphia) made a particularly successful operation on an epileptic boy of sixteen who, in ten years, had five thousand fits. An extraneous growth of nearly an ounce was removed from the right parietal region. Another expert has predicted that in course of time operations on the brain will be performed for the relief of apoplexy and epilepsy, and that such operations will be successful. A few years ago there was a little girl patient in one of the hospitals of Paris. She exhibited almost an utter absence of intelligence. She had a mournful look, lack-luster eyes, and could not be aroused even to take an interest in dolls. She breathed with difficulty in consequence of the thorax having stopped its development, and her brain had ceased to grow at an early age, owing to the premature coalescence of the bones in infancy. The surgeon, Lannelongue, attributed her unfortunate condition to the narrowness of the cranial box, and believed that if more space were given to the brain her idiocy would disappear and she would attain a normal existence. The operator, who had previously experimented on dead children in studying the same trouble, made a long and narrow incision in the middle of the skull, and on the left side, which was more depressed than the right, removed a substance of tissue bone nine centimeters long by six millimeters broad. The dura mater, which is the exterior envelope of the brain, was not touched, and the superficial wound was united by the skin again. Within three weeks after the operation there was a remarkable change in the child; she walked, smiled, and became interested in all that was going on around her. An operation exactly parallel to this was performed by an American surgeon in Cincinnati; in this case the child was much younger, but the operation was completely successful.

Another singular case was that of a housemaid employed in a New York family. She began to show signs of exceptional stupidity; so much so that she became unable properly to attend to her duties. Her employer was compelled to discharge her. One of the first things the girl did was to visit a New York hospital on a friendly call to her sister, who was employed in the institution. The discharged servant had often complained of having severe headaches. A house physician in the hospital, hearing her speak of her trouble, made an examination of her head and found that the bones of her skull had never knitted together. A surgeon operated on her head and succeeded in closing the aperture. Only a few days after the operation the girl became as bright as she had ever been, was taken back by her former employer, where she was soon recognized as one of the most accomplished housemaids.

At the Presbyterian Hospital, New York, three years ago, there was a boy of seven who had suffered from ear trouble for two years. He suffered so much from headaches that, as he said, it seemed at times as if the top of his skull was coming off. Sometimes he would fall suddenly limp and apparently lifeless. In the midst of a sentence he would lose the power of speech. He would remain unconscious for fifteen minutes, restoratives having no effect upon him, the fits being followed by a sort of acute delirium, when he would rave and talk nonsense. Then he would fall asleep, and awake after several hours, restored mentally, but exhausted physically.

The operation of opening the ear through the natural channel was decided upon. The ear, which was illuminated with an electric search lamp or electrode, showed a high state of inflammation. In the operation the drumhead was loosened from the auditory plate. The little mallet and anvil-shaped bones in the middle ear were found held in position, although there were marks of decomposition. It was found necessary to remove these bones even at the risk of life, as they would continue to decay in defiance of all treatment. After further cutting the surgeon invited those present to look through the spectrum. One of the students said he could see a bright shining point near the eustachian tube and wanted to know what it was. It seems that the surgeon had not noticed it. He quickly looked through the instrument and saw the point. He touched it with a probe, and it moved. Then he withdrew it with a pair of forceps and, to the astonishment of the bystanders, it proved to be a small brass pin which had been the cause of all the child's suffering. It is very rarely the case that a pin can pass the drumhead of the ear, but the investigation shows it must have done so in this instance.

Laparotomy, or the operation of cutting open the intestines for the purpose of treating gunshot wounds in the abdomen, had never been performed in New York until 1885. Since then the operation has been of comparatively frequent occurrence. Cancer of the stomach cannot be cured by medicine, but three years ago a rare operation in this disease was performed on a patient in a Philadelphia medical college. The cancer, in this case, had closed up the passage through which food passes from the stomach into the small intestine, and the man was actually starving to death. The surgeons cut away the diseased portion of the stomach and intestines. The operation, though very rare and dangerous, had the effect of prolonging the patient's life for a time, but the cancerous growth was too extensive to hope for a complete cure.

Four years ago there was a man residing in Washington, D. C., who was living with only half a liver. Some persons who suffer the pangs of melancholy from torpidity of this organ doubtless think they could get along without it entirely; but a person living in reasonably good health with but half a liver is a curiosity. The person referred to had been a seafaring man, had cruised much in far eastern waters, and had what is known among sailors as a "tropic liver;" on land the disease sometimes goes by the name of "baked liver," or yellow jaundice. A sailor who contracts this disease in a hot country, on coming to a northern latitude will find his liver harden, so that it will seem to be a lump on the side. The sufferer above referred to was operated upon by an Italian physician in southern Italy, where liver troubles are of frequent occurrence. The condition of the patient was very desperate, and the surgeon cut away the hardened, or baked, part of the liver, which refused longer to perform its natural functions, and was a dead member—like a withered arm or a paralyzed side. The diseased end of the liver was drawn out where it could be inspected, and the useless part, or the most of it, taken away. The remaining part was treated, to prevent hemorrhage, and placed back where it belonged. It has been stated that there are not half a dozen cases in which such a bold operation has been performed.

A man from a Western city came to New York to be treated for severe and deep-seated pain in the lumbar region and sanguinaria, after having vainly tried poultices, liniments and internal remedies. The surgeon who examined him declared that he was suffering from "floating kidney," i. e., detachment of the kidney from the spine, to which it is attached in the vicinity of the eleventh and twelfth ribs; he also believed that there was a suppurating abscess in the center of the kidney. The operation showed the diagnosis to be correct; the surgeon found a floating, enlarged and diseased kidney, which was entirely removed with the knife, so that the patient is now living and in good health with one kidney.

About three years ago there was born in one of the wards of the New York Emergency Hospital a male child minus a mouth; the cheeks were united from ear to ear by smooth, white skin and flesh. An operation was performed which resulted in the making of a mouth. Before the wound was bandaged plugs of pressed cotton were placed between the jawbones to keep them from coming together, and pressed cotton was applied behind what would be the lips, so as to have them protrude naturally; the mouth was held open by plugs, the wound was bandaged and healed in a few days, the mouth having formed itself and being quite natural in appearance.

Many interesting instances could be given of bone grafting and transplanting skin. A man in Kansas City accidentally slipped in a soap vat where the boiling soap was thirteen inches deep. The skin was almost entirely removed from each leg. After the wounds had been treated the grafting process was commenced, the "grafts" being nearly all taken from the arms and legs of no less than one hundred and sixty persons who volunteered to help the poor fellow along. On an average they were about the size of a drop of water. When put on the injured man's legs they were placed about one-eighth of an inch apart. Every "graft" grows a sixteenth of an inch each way. To prevent them from lapping over, they were placed so far apart that they would grow together. If placed closer than this, they cause an uneven surface and leave scars. An interesting discovery made in this case was that the skin of a black man when "grafted" into the body of a white man will lose its color and become white. The same rule, it is claimed, will not apply to white skin put on the body of a colored person. It seems that the "graft" would not stick on a certain point in the man's legs. It was decided to try a "graft" from a colored man. This adhered, and in five hours after being applied turned as white as the patient's skin.

Only a few weeks since the daily papers reported the case of a boy in Philadelphia who was suffering from necrosis or gangrene of the shin bone. The decayed bone was removed and replaced by a section from a sheep's leg, special pains being taken to retain the periosteum or membraneous substance covering the bone. This is the first time such an operation has been performed. Bone grafting has heretofore proceeded on the principle that the foreign bone inserted must first be powdered and freed of its lime and chalk. At last accounts the boy was doing well, and, should the experiment prove entirely successful, it will show that the bone from an animal must be transferred entire.

Some surgical operations have revealed strange psychological peculiarities. A Brooklyn man, a bookkeeper, aged twenty-seven, while returning from his work, was attacked by thieves and escaped with a fractured skull. He seemed to recover under the usual treatment, but became a changed man. He could not talk straight, and he had lost his memory and his reason. He became an imbecile. His young wife went to work at dressmaking and was so engaged for eleven years, by which time she had been made the forewoman in a large establishment. She was always taken to be a widow. To a customer who seemed specially interested in her she one day told the story of her troubles.

The customer introduced her to a specialist in brain surgery, believing that he could help the husband. The surgeon removed a fragment of bone from the brain, and the patient recovered his speech and reason immediately. But the previous eleven years was to him a complete blank. His whole character, also, changed. He had been mild-mannered and cheerful; he became sullen, irritable and given to violent outbreaks of bad temper. He refused to work steadily, stole money from his wife and insisted that she should support him. She was compelled to refuse to live with him. The man, who had always been moral and sober, became a habitual drunkard, stabbed an acquaintance in a drunken quarrel and fled from the city, finally dying in a public institution in the West. It has been argued that the change in the character of this man may have been brought about by the surgical operation, and that being the case—a good man having been made bad—why is it not possible, by a surgical operation, to make a bad man good?

The case is reported of an irritable crank having been changed, by a surgical operation, into a rational human being. A farmer, who had tried to shoot his wife, was arrested, sent to the reformatory, subsequently showing great irritability, and finally becoming insane. An insanity expert found that he had a fracture of the skull which had not been closed by bony union. The surgeon discovered, and drew off, a quantity of diseased fluid. The patient regained his senses, became robust in health, and, what was most remarkable, level-headed.

Prof. Moritz Benedikt, of Vienna, who has made a special study of criminals in Austrian prisons and dissected their brains when they died, has reached the conclusion that "the brains of criminals are to be viewed as an anthropological variety of their species, at least among the cultured races." In a work upon this subject he says:

"An inability to restrain themselves from the repetition of a crime, notwithstanding a full appreciation of the power of the law (society), and a lack of the sentiment of wrong, though with a clear perception of it, constitute the two principal psychological characteristics of that class to which belongs more than one-half of condemned criminals. A consideration of no less importance is the fact that the same defect of moral sensibility and will may remain concealed by superior mental organization and greater dexterity in criminal mental disorder."

A SUGGESTION OF A USE FOR THE RARE METALS.

By HENRY C. DEMMING.

MICROBES are coming to the front in pharmacy. The day is not far off when the skilled pharmacist will find it necessary to have a good microscope, as well as much knowledge of botany. But he will not be able to stop there. Scientific research now demonstrates that pharmacy may soon require mineralogy as a handmaid to botany. The reason of this is apparent to any one who has kept abreast of the strides of the most eminent scientists of our day. Several very learned and able men found the microbe which exists in disease; and others, notably Professor Koch, found the microbe that exists in pulmonary diseases. Some other scientific mind or minds found that bacteria belong to the vegetable kingdom; at least, that is claimed by able investigators just now.

Then, patient investigation has led to the discovery of different families of bacilli. For instance, one species is dominant in pulmonary diseases, another in diphtheritic cases, another in scarlet fever, another in smallpox, and still another—more attenuated—in Asiatic cholera. Possibly membraneous croup has its peculiar bacterium, but I believe that has not been definitely ascertained. Neither has it been ascertained, as yet, the peculiar species which may exist in cases of aggravated diphtheria. The molecular disintegration of the cellular tissues of the brain possibly has its own peculiar family of bacteria, and even earache may be traceable to a distinct species.

Then, further patient research—and I think much of this is due to the labors of C. A. Mitchell—has led to the publication of the fact that there are, at least, seventy distinct species of color-producing bacteria, many of which are perfectly harmless to man. The bacteria discovered in the corners of the mouth of a healthy person, though extremely poisonous and dangerous in certain conditions, can be classed usually with the harmless varieties.

But, before I go into deeper water—and perhaps I ought not to go deeper in an article at this time—it has been made manifest that these different colored micro-organisms require different treatment, to lead to their annihilation. The several species capable of throwing off a reddish coloring matter—from the faint pink to the deep blood red—may require quite different treatment to lead to their destruction than would be required for bacteria producing a blue color—from the light slate blue to the deep blue color of the thousand fathomed sea. So with the green, the violet and the brown, as well as the other colors.

Some labor will have to be spent in determining accurately which are injurious to human life, and which are harmless in health; then to determine which become harmless to one apparently healthy, and incapable of enduring much exposure. Then comes the task of determining which are most injurious when disease appears, when disease is well under way; and how the microbes are to be treated, if treated at all, when the disease has shown signs of conquest.

In these investigations it has already been clearly demonstrated that the products of the botanical world are futile, no matter how administered, when certain microbes appear. Dr. Meade Bolton, in England, followed out some experiments which had previously been carried on by others, until he realized that there are certain metals which are capable of destroying microbes in contact with them. He cultivated certain species in jelly, spread upon a plate; and bits of metal were dropped upon the jelly while it was still moist. He found that any metal that could arrest the development of microbes destroyed them; not only those which came in direct contact with the metal, but other microbic life for a narrow space around the metal. This potentiality varied, not only with the kind of metal, but with the species of microbes. He found that pure gold produced no effect; neither did pure nickel, nor platinum, nor a few other metals that he tried. But copper, zinc and silver were effective in some instances, though cadmium acted quickly and effectively in almost if not every instance. The

learned doctor observed that the metals which affect the microbes were those that are readily attacked by chemical reagents, while those that resisted such reagents, like gold, had no effect. He concluded that the action upon the organisms was due to the solution of the metals taking place in the jelly.

But what a wide field he has opened!

Here is a world for exploration, with promise of rich reward. You have many readers of an investigating turn of mind. Many of them have their own private microscopes, and bacteria are to be found on every hand in abundance. Metals of some description are on every shelf. Who will be the first to discover that some other metal than cadmium is destructive of the peculiar species of bacteria so prevalent in serious cases of scarlet fever? and then how many diseases, with their peculiar species, there are in this wide world of disease and death!

It may be necessary, in conducting these experiments, to resort to many species of the rarer minerals, and to reduce these species to metals and solutions. But we have the young men who have the ability, the skill, the patience and the time to solve the important problems.

The question may arise where to obtain the metals or minerals. Having given this subject much special study during the past fifteen or twenty years, perhaps I can supply the key whereby any known mineral or metal can be provided when wanted. It is a remarkable fact that when a so-called rare metal is required for commercial use, that somebody, somewhere, will, in a comparatively short time, be able to supply the article.

Take our Welsbach light, manufactured at Gloucester, N. J. When the manufacture was first attempted in the United States, the officers of the Welsbach Company sent out letters in every direction for minerals containing the metals they wanted. They had to experiment some time before they really made much headway; then they concentrated on one or two minerals—one known as monazite. Then the problem: Where can this mineral be found in sufficient quantities to enable the company to supply the growing demand for their manufacture? At first they met with very moderate success—perhaps some people would have pronounced it failure. But they kept on; and now they can purchase all the monazite they require, either from North and South Carolina, or Brazil, with small quantities now and then from other localities.

A number of years ago Mr. Thomas A. Edison wanted one or two rare minerals for his purposes. At first they could not be supplied satisfactorily; but, as the demand grew, the product increased, and now the tip of every phonograph receiver has a sapphire point, and the mineral itself is supplied at fabulously low prices. A party in France wanted zircon for their establishment, and it seemed at first that they never could obtain enough; but a gentleman in North Carolina mined and shipped them 600 pounds, a larger quantity than had ever before been found, and an abundant supply for their purposes. But the uses of zircon have since multiplied. The product has multiplied also, and now it is not an unusual thing to hear of a whole carload of this once rare mineral being shipped.

Returning to monazite—which is a mineral containing cerium, didymium, erbium, lanthanum, thorium and yttrium. Here are rare metals, varying in price from $10 to $360 a pound. If any of them should be found wholly efficient in destroying any species of bacteria, there is no doubt that the metal would be forthcoming in any quantity necessary to meet the demand of the medical world. As proof of this I am now mining and shipping to Europe many thousands of pounds of the mineral from which these metals are derived, and have no fear that I shall not be able to fill any order which comes along not exceeding a thousand tons.

Other very rare metals exist in monazite, and also in samarskite—in the latter such rare species as columbium, terbium, decipium, tantalum, argon and helium, some of which are possibly entirely unknown practically to many chemists, as well as those engaged in other sciences.

Euxenite, another very rare mineral, also contains rare metals, such as germanium and uranium, as well as argon and helium. Antidotes of the poisons of these various bacilli cannot be said to have no existence until these various metals have been tried. Then arises another difficulty, to be swept away, if possible—the use of a metal to destroy certain micro-organisms, and the metal itself to be non-injurious to the human body. That this will lead to much experimenting, there is no doubt; but, of course, none of the first experiments should be made on human beings, no matter how aggravated the case.

Referring again to euxenite, samarskite, and the element helium, derived therefrom, when helium has been utilized to produce artificial sunlight—for the sun contains helium—then we will have a light to experiment with far in advance of the electric bulb now placed in the human stomach for the purpose of clinical and other observations; and when helium is put into further practical use, we will also have something to work by in our laboratories that will be akin to sunlight, and thus save many a sweltering and many a headache now caused by modern artificial lights.

Acting upon the discoveries of Dr. Meade Bolton, the searcher for that which will lengthen human life by destroying disease will most likely be guided by the cue, given by the doctor, that the metals most readily attacked by chemical reagents are most effective in the destruction of microbal life. A comparatively short investigation will enable the student or the searcher after this knowledge to make a list of the metals required. Possibly, most of the metals on the list can be obtained at once and with little difficulty. But when the others are desired I would suggest that they be sought through parties skilled in obtaining them, either in the United States or abroad, and I believe it is now conceded that every known mineral and metal has been found in the United States, and by far the largest number in Virginia, North Carolina, western South Carolina, Georgia, Alabama and eastern Tennessee. Only a short time ago, in an area of less than five square miles, I found and classified 138 species of minerals, more than half of them of the rarer varieties. I believe it is possible to make even a longer list, and that the locality I refer to is not the only place in the United States where so many can be found.

It is quite evident, then, that when an antidote is found, the mineral will be forthcoming in ample quantities to make the antidote effective and widespread.

It seems to the writer that all these medicinal elements for the restoration to health of bacteria-troubled patients is right in the line of advanced pharmacy. Being in that line, why ought not the pharmacists of this country to be first to make efforts in the way where they will naturally travel ere long? I shall watch with keen interest any steps taken by the pharmaceutical world in the direction pointed out in this article.

Harrisburg, Pa., September 12, 1895.

—American Journal of Pharmacy.

THE PHOTOSPHERE.

WE gave a description of this well-conceived apparatus for instantaneous photography at the time of its advent. The structure of this instrument, which is all of oxidized metal, its lightness and its compactness make of it a very practical apparatus always ready to operate, and one required by tourists and explorers, to whom it has rendered great services. Since the above-named epoch, the photosphere has been further improved. The Zeiss objectives, which are remarkably luminous and which completely correct astigmatism, constituted a progress upon aplanetic objectives. The Krauss establishment, which has obtained the right to manufacture these objectives, has

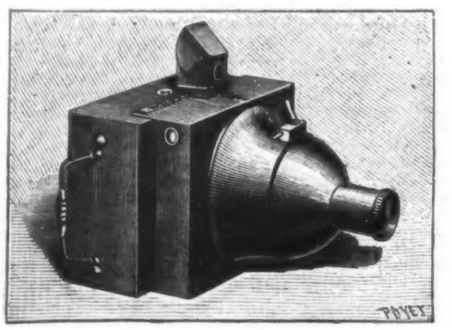


FIG. 2.—THE PHOTOSPHERE PROVIDED WITH ITS REPEATING FRAME.

got up some special types for use in the photosphere. All these objectives are provided with iris diaphragms with ebonite plates that prevent the reflections that occur upon metal ones after a little use. A simple rotary motion given the objective suffices to modify the diaphragm's aperture, which is indicated by a very apparent graduation.

All amateurs who know how much want of success is due to the impossibility of modifying their diaphragm according to the illumination of the object will appreciate this so simple and convenient system. These short focus objectives are always in focus from infinity up to 5 meters. An optional focusing can be effected for nearer objects by using either a ground glass or a graduation that is carried by the apparatus.

The frame of the first model of the photosphere, which was of varnished mahogany, was subject to alteration under the action of heat and moisture, and its method of closing and of maneuvering in the apparatus left much to be desired. This inconvenience has been obviated by the construction of frames all of tempered steel.

Many amateurs now, following in this the fancy of the Americans and English, are desirous of being able to take a series of negatives rapidly without having to change frames or to bother themselves with the operation of the apparatus, which should be automatic. The manufacturer of the photosphere has thought it well to satisfy this new fancy by adopting a repeating magazine frame analogous to that of the "photo-jumelle." The principle of this frame is borrowed from the Hanau-Richard patents, and is the simplest and most rational system; but its being made entirely of metal gives it extreme lightness and strength. The management of it consists simply in pulling out and shoving in a drawer.

The accompanying Fig. 1 gives three different aspects of this new frame. No. 1 is a section that shows the interior and allows the operation to be seen. B is a box into which the drawer, A, slides. In this drawer there are twelve plates to be impressed. Fig. 1 (No. 1) represents the drawer, A, which has been drawn out along with eleven plates. The twelfth plate, P, is held in the box and falls at P' when the drawer is pulled out to its full extent.

When the drawer is shoved in, this plate places itself under the eleven others. The second plate, which has now become the first, will, in turn, come into the focus of the apparatus.

Upon pulling out, through its handle, the drawer that contains these plates, there is carried along a curtain, R, that renders it light-proof. A second curtain, R', is maneuvered by hand and closes the magazine when it is desired to carry it alone after detaching it from the photosphere. Fig. 1 (No. 2) shows the mechanism of the counter. Every time the drawer is maneuvered it actuates a lever that causes a numbered disk to move forward by one notch. A figure appears upon the box and designates the row of the plate to be exposed. No. 3 represents the frame closed and No. 4 the same half-opened, as well as the place occupied by the counter.

Fig. 2 shows the photosphere provided with its repeating frame. This magazine frame may be employed concurrently with the ordinary frames and be adapted to the present photospheres without the necessity of any modification.—La Nature.

ON THE PHOTOGRAPHY OF THE RAYS OF SMALLEST WAVE LENGTH.*

By VICTOR SCHUMANN.

PREVIOUS experiments which I had performed with strata of air up to 1 mm. in thickness had shown that the photography of the light rays below the wave length 185 $\mu\mu$ required the exclusion of air from the track of the rays. Under these circumstances, an essential extension of the spectrum of the air beyond the wave length 185 $\mu\mu$ seemed impracticable. But according to my most recent experiments, very thin strata of air, such of about 0·1 $\mu\mu$ in thickness, transmit a great part of the rays of the smallest wave lengths, and strata whose thickness does not exceed a few hundredths of a mm. seem merely to check, but not to quench, the energy of the rays. With the former the photograph extends far beyond 162 , the locality of the photographic maximum of hydrogen; while with the latter we are able to proceed considerably further. Indeed, according to all appearance, these, if only exposed for a sufficient time, may present no important hindrance to attaining the actual limit of the region of the smallest wave lengths.

From this fact, which I have repeatedly verified, I believe that I can deduce a result concerning the photography of the smallest wave lengths totally unexpected in accordance with my earlier observations. I employ a discharging tube, so constructed that it may be connected air-tight with the exhausted spectrograph in a manner suitable for photographic application, and thereupon, independently of its vacuum, can be filled with any required gas at any given pressure. The tube and the spectrograph, therefore—in an essential contrast with my former experimental arrangement—were not in conductive connection. This discharging tube, differing in form and arrangement from my previous arrangements of this kind, presents, along with other advantages, one which comes exclusively into consideration in the present case, i. e., that the resistance of absorption which the rays encounter by the contained gas can be reduced without difficulty to an extremely small quantity by a decrease of pressure and depth of stratum.

I purpose subsequently to communicate further particulars with my photographs—now in course of execution—of the ultra-violet spectrum of hydrogen.

With such a tube I now obtained, after it has been filled with dry air at a low pressure, the spectrum of the air as an extremely energetic band of efficacy, of a wave length hitherto not attained, which closely approximates, in photographic energy and extent, to the most effective of all the ultra-violet spectra hitherto known, that of hydrogen. For instance, the most effective region of these pictures presents in a length of 34 mm. more than fifty bands, partly resolved into lines shading away toward the red and following upon each other so closely that in their totality they appear to the naked eye as a continuous effective band of varying density. To what constituent of the atmosphere these bands belong future observations must decide.

* Imperial Academy of Sciences at Vienna, Session of the Class of Mathematics and Natural Science, April 25, 1895.—Chem. News.

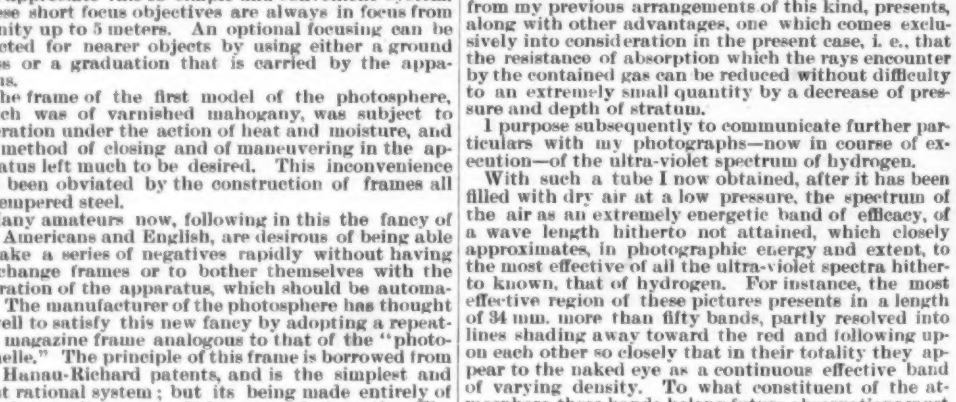


FIG. 1.—DETAILS OF A MAGAZINE FRAME CONTAINING TWELVE PLATES.

MAGELLAN'S STRAIT.

Magellan's Strait is a sea passage separating the mainland of South America from the group of islands called Terra del Fuego, and affords a natural passage from the Atlantic to the Pacific. Its length is over 300 miles. The eastern entrance is formed by Cape Virgin on the mainland and on the island by Cape Espiritu Santo. The strait is difficult to navigate by sailing vessels, as the tides are swift and reach an elevation of about 50 feet. The strait was discovered by Fernao de Magalhaes, a Portuguese navigator, who was born in 1480 and died in 1521. He is principally known by his discovery of the strait which bears his name, which he made on October 21, 1520. He reached the Pacific by passing through the strait on November 28, and on March 16, 1521, he discovered the Philippine Islands. The Spanish changed the name to Magellan, and the name Magellan's Land was long given to Patagonia, and that hypothetical continent of which Terra del Fuego was considered only a part. The name has been again bestowed by Chile on the territory which she claims in the extreme south.

THE ISLES OF SHOALS.

By Horace C. Hovey.

In 1614 the renowned Captain John Smith discovered a group of nine islands to which he gave his own name. But for some reason the name was changed in the deed granted by the Sagamores to John Wheelwright in 1629 from Smith's Isles to the Isles of Shoals. It has always been in dispute as to whether the "shoals" were the ragged reefs that environ the group or the shoals of herring and mackerel that frequent the surrounding waters. The group lies in N. latitude 42° 59' and W. longitude 70° 30' from London, nine miles S. E. of the Portsmouth Light and twenty-one miles N. E. of the Newburyport Light. Five of the islands belong to Maine, namely, Appledore, Smutty Nose, Malaga, Cedar and Duck, while the other four are in New Hampshire, namely, Star, White, Seavey and Londoner. Formerly Appledore bore the less agreeable name of Hog Island, by which it is still called on the government charts. Smutty Nose was once called Haley's Island in honor of its owner, Mr. Samuel Haley. Malaga got its name from the Spanish sailors who in former times carried on an extensive trade with these isles. Cedar Island was once densely covered with cedar trees, only a few stumps of which remain. Duck Island is a favorite resort for water fowl. The origin of the other names is conjectural. There are besides the islands mentioned several notable rocks that stand a few feet above high water mark, and also the sunken reefs already noted. According to a survey made in the year 1800, Appledore is half a nautical mile long and three-eighths of a mile wide and contains 350 acres; Star is five-eighths of a mile long, half a mile wide and has 150 acres; Smutty Nose is half a mile long with 100 acres; the other islands of smaller dimensions, and the entire group having perhaps 800 acres, although it is not stated whether these measurements include only what is covered by soil or the entire rocky areas exposed at low tide. As the mean tide is reported to be 8 feet 6 inches, this would make a considerable difference.

As to the distances between these islands, it may be said that Londoner is three-quarters of a mile southwest from Appledore, and the same distance west of White Island; Star is nearly a mile from White, and Smutty Nose is a quarter of a mile from Star, and is joined to Malaga by a sea wall 150 feet long, and to Cedar by one much longer; while Duck Island is perhaps two miles apart from the rest of the group, and is seldom visited on account of the difficulty in landing.

It is hard to realize that the Isles of Shoals were once inhabited by more than 600 permanent residents, who carried on extensive fisheries, maintained trade with Europe, had windmills, a great ropewalk, a brewery, a distillery, besides a noted academy, and a unique meeting house built of materials taken from wrecks, whose faithful minister was one of the best paid clergymen in New England. Aside from a few dilapidated cottages, and the ancient meeting house, the ruins of a fort whose cannon once defied invaders, straggling stone walls, and here and there a rude cairn on some headland, nothing remains of that busy population of a century or more ago but their moss grown and neglected graves. Some of these are marked by marble stones, and Captain John Smith has a cenotaph that is out of repair. But in most cases the only sign is an uncouth fragment of granite never touched by hammer or chisel. In an uninclosed space I found on a broken slab of Wales slate the epitaph of Mr. Samuel Haley, stating that "He was a man of great ingenuity, honor and honesty, true to his country, and a man who did a great public good in building a dock and receiving into his inclosure many a poor distressed fisherman in distress of weather." Haley's cottage still stands, from whose attic window, long before there was any lighthouse in this vicinity, he displayed nightly for many years a warning light for mariners. His admirable sea wall, between Malaga and the island that ought always to have borne the name of Haley's Island instead of the absurd one of Smutty Nose, abides as firm as when he built it at his own expense a hundred years ago; while the costly government wall to Cedar Island is in ruins and is visible only at low tide, a menace instead of a protection to vessels seeking this only harbor of the isles.

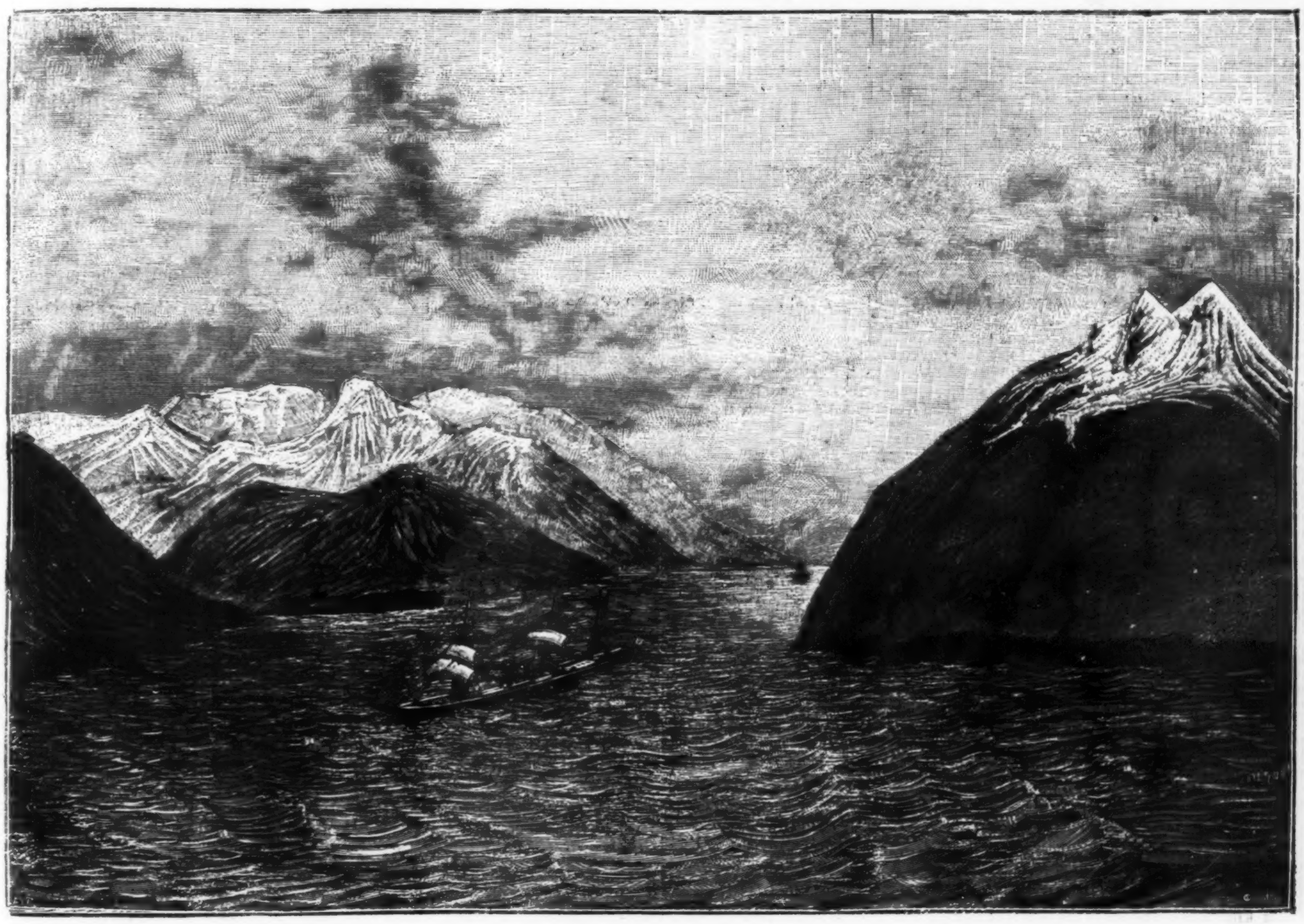
Deserted during most of the year, the Isles of Shoals are thronged in summer with tourists who fare sumptuously at the spacious hotels reared by the Laighton Brothers, by whom the group is mostly owned at present. Their father, the late Mr. Thomas Laighton, was long the keeper of the lighthouse on White Island, a locality that I visited with much interest. There is but one landing, where the boat must run its nose between parallel timbers and be drawn up to the boat-house by hand or by a capstan, and the island can only be approached in good weather on account of the breakers. Its tall white cliff commands the best view of the entire group, as well as of the coast line; and on fine days the White Mountains are visible. The new lighthouse, erected in 1857, is eighty feet high and carries a flash light of the second magnitude. The violence of the wintry storms can be inferred from the fact that the spray dashes completely over this tower, coating the windows of the lantern with salt, so as to make it necessary to clean them twice a day. On top of the cliff, at a point fifty feet above the tide level, I saw a bowlder weighing many tons that was recently tossed there by the waves.

In spite of such storms there are a few hardy trees on the Isles of Shoals, and many shrubs, vines and wild flowers. There is a good acreage of grass land, and would be more had not the former inhabitants cut up the turf for fuel. Mrs. Celia Thaxter's experiments with poppies and marigolds proved the soil to be singularly productive under right treatment. The volumes of this gifted authoress, as well as those of De Costa and Jeness, have served to make known the history and curious legends of these isles that are so enchanting in summer and so bleak and dreadful in winter. I made out a list of the fauna and flora, but found nothing specially different from what belongs to the rocky shores of the mainland.

My principal object, however, was geological, and I found much to reward my rambles over the rumpled and twisted rocks. Hitchcock, in his report of the New Hampshire survey, speaks of the Isles of Shoals as "a neglected group;" which is a good description from a scientific point of view. De Costa says that the Maine geologists came on a windy day, landed at one or two points, found much surf running, and went home satisfied. This may not do them justice; but several noted geologists from Massachusetts owned up to having paid more attention to the Appledore bill of fare than to the rocks in the vicinity. Hence the writer was encouraged to traverse every little island from center to circumference, to follow the kelp line around several of them, and to take a few soundings in order to find out the nature of the sea floor. The work has been imperfectly done, but it is hoped that the results may stimulate others to make further research in this "neglected group."

One thing that greatly interested me is the fact that while Appledore seems to be stationary, Star, Haley, Cedar and Malaga islands are being somewhat rapidly lifted above their former level. Among proofs of this theory may be given the testimony of aged fishermen that the channel between Star and Cedar islands was six feet deeper fifty years ago than it is to-day. I was also assured that when the hotel on Appledore was built its flagstaff only could be seen from Star Island, whereas its entire cupola is now visible. Various facts of a similar nature were given. But what seemed most striking to my mind was the lifting of "Neptune's Punch Bowl." This is a pothole on Star Island, three feet in diameter and six feet deep, that was pointed out to me with the information that the Indians made it for grinding maize. But as similar potholes are now being cut by revolving bowlders along the north shore of Malaga, we may fairly infer that the one on Star was cut in the same way. In each instance the opening is pointed toward the sea and rounded at the side farthest from the water, showing that the bowlder bounded back after having been hurled by the waves against the inshore side. All of them take advantage of lines of weakness in the ledges from which they are excavated.

The fishermen, natives and persons who had long resided at the Shoals all agreed in saying that Neptune's Punch Bowl used to be washed out by every



THE COASTS OF CHILE—VIEW OF THE STRAIT OF MAGELLAN.

tide, and for that reason was used by the fishermen as a basin for cleaning fish, because they were always sure of clean water. At present it is not less than 100 feet back from the margin of the sea, and is about six feet above it vertically. On telling Prof. Hitchcock of these proofs he said they agreed with some of his own observations along the coast, showing that there was a gradual elevation of certain areas now in progress.

Signs are visible on every hand that the group was originally lifted from the ocean floor, and that since then it has been subjected to both igneous and glacial action. The ledges are tilted in various directions, the prevailing dip being from east to west, or nearly so, and at an angle of about 20°. But the ledges are so broken into huge fragments, tossed about at every possible angle, as to make it somewhat difficult to decide these matters.

The problem is complicated by remarkable foldings and rifts. We may safely say that the rocks are mostly granite; but the petrography of the isles remains to be determined with accuracy. The granitic ledges are sometimes like fine grained sandstone and again like the most coarse conglomerate, in each case seeming to have been partly vitrified by intense heat. Gneiss of every variety is abundant. So is mica slate; as well as conspicuous crushed crystals of both biotite and muscovite. Seams of quartz and feldspar run in all directions, varying in width from one inch to many feet. These seams are sometimes very straight and regular; and again they waver or are strangely contorted like a folded accordeon of gigantic size. Here and there the seams look like layers of fine mosaic arranged by some pre-adamite artist.

At a point near Neptune's Gallery, on Appledore, is a fine example of segregation. The end of a core a foot in diameter protrudes like the end of a pudding stick; and wound around it, like layers of mush, are circular coats of granitoid rock till a mass is thus formed thirty feet thick. Near this concretion is one of the best examples of "slickensides" I have ever seen, the rocky face having been polished like a mirror over a space four feet square. In the vicinity is a chasm, one wall white and the other black, from whose top two blocks of the different kinds of granite simultaneously started for the bottom, and being equally eager they got wedged together midway, where they still hang by their tips.

Signs of igneous action are frequent and impressive. The dikes run for the most part north and south, though occasionally from east to west, with intersections like what is called the Greek Cross on Appledore. The trap rock yielding more readily than the granite to the action of the sea, chasms are thus formed through which the waves rush with violence at high tide. The huge blocks of basalt often lie in a manner to justify the etymology of trap, from the Swedish "trappa," meaning steps or stairs. Romantic stories are told of infatuated persons who have resolutely gone down these natural stairways to their doom. The grandest dike on the group is on Cedar Island, of epidotic diorite, stretching from shore to shore, with great crystals of ferruginous feldspar running through the porphyritic center, like so many plums in a pudding.

But I wish to describe particularly what may be called the Appledore Column, pointed out to me by Mr. Walter Wood, a visitor from South Orange, N. J. It stands in a ravine quarter of a mile back from the hotel, protruding from a bed of biotite gneiss much softer than itself, and also softer than the granitic walls of the chasm. The largest diameter of this unique column is eleven feet and its shape is sharply hexagonal. It contains grains of feldspar, quartz, biotite, muscovite and associated minerals, and shows signs both of crushing and of baking. It is wholly unlike the mass from which it arises and also the walls of the ravine. It is but a short distance above high water mark, and has been repeatedly assailed by the waves during storms. This has made it give way at the lines of cleavage, breaking off in regular slices of equal size and with parallel faces.

The topmost fragment in view is a double slice 36 inches thick, lying 100 feet northeast of the main column. The next fragment, also a double slice, 36 inches thick, and also northeast of the column, is in contact with it. The present summit of the column is 20 inches thick and lay between two adjoining planes of cleavage, or, in other words, is a single slice. Underneath it are two sections still in place, and each 20 inches thick. All the slices were probably of the same original thickness, the existing differences being due to abrasion. Thus the known height of the column, being equal to the combined thickness of the slices, is 140 inches. How much higher it may once have been we cannot know, but think it must have gone to the top of the ravine, that is to say, about 25 feet. The distance it goes downward could only be determined by excavations around its base, a task not yet undertaken.

When first observed, in 1890, the present top slice was nearly in situ, having been driven back only two inches. During successive winters it has been forced back so as to uncover fully five feet of the next lower portion, and to impinge on the two slices that had been previously removed. One of its six faces has the weathering chipped away by the blows of the bowlders; but a patch of harder material clinging to the slice exactly matches a similar patch on the rock below. Whether this column is, as has been suggested, an igneous plug, or is a shaft of compressed granite, as is more probable, the occurrence is unique and noteworthy.

Among forces that have been at work to break down the rocks of these islands electricity must not be forgotten. The guests at the hotel marked where a bolt struck on Appledore and Mr. Wood and I visited the spot. We found that huge rocks weighing many tons had been shattered by the blow. Glacial action has also done its share in prying ledges apart, scooping out channels, and in the opinion of some severing the islands from the mainland. But what were shown to me as signs of glaciation seem doubtful in view of the work of denudation and disintegration now going on. I examined critically what others have described as a foreign bowlder, a mass 15 feet long by 12 wide and 8 thick, on the sumit of Appledore. It is exactly like the ledge on which it lies, only being grained transversely. Possibly the force that turned this rock at right angles was glacial; but more probably it was aqueous.

Many proofs are visible of the violence of the waves about these storm beaten islands. A belvidere built of wrought iron was twisted from its hold on the rocks and whirled away. A spindle shaft of wrought iron nine inches in diameter, on Anderson's Rock, was snapped off "like a pipe stem" last winter, and is now replaced by one thirteen inches thick, which it is hoped may stand the strain. The Laightons built a wall six feet high and six feet wide to protect the Appledore Hotel; but a single storm broke it all down and scattered the massive stones. Only last winter a storm swept bowlders completely across the island, underneath the hotel, and down into a basin where the boats were moored for the season.

Considering the forces electrical, aerial, glacial and aqueous that have for ages been grinding these rocks to powder, we are prepared for the theory on which Prof. Sears accounts for the sands of Salisbury Beach and Plum Island. It has been supposed that these were brought down from the mountains to the shore; but he shows the comminuted minerals to differ from those inland ledges. And on the other hand, the microscope reveals the garnets, orthoclase, diorite, biotite, quartz and other minerals found on Appledore. Thus it seems probable that the dunes at the mouth of the Merrimac were once ledges at the Isles of Shoals.

THE REFUGE TUNNELS OF NAOURS, FRANCE.

WE have already spoken several times of a special category of cavities in the earth, usually artificial, that are quite widely distributed in France, and are called refuge tunnels, because they have been used as places of retreat at various troubled epochs by people fleeing from hostile invasions. While certain archæologists date the majority of such excavations, which are often formed in deserted quarries, only from the middle ages. Lieutenant Colonel de Rochas ascribes a remoter antiquity to the refuge of Bretigny, near Chartres, which he thinks was inhabited by the Gauls during the Roman conquest.

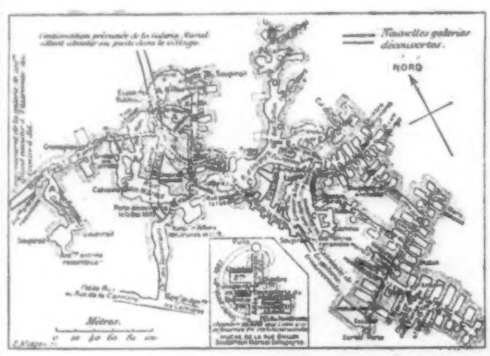


FIG. 3.—PLAN OF THE SUBTERRANEAN GALLERIES OF NAOURS.

The continuous black lines represent the galleries recently discovered.

There is here a question so much the more curious and useful to study in that, up to the present, important remains of the historic ages have scarcely been found in either natural or artificial caverns in France; for we cannot compare the products of the researches made in the grottoes of Lamouroux (Correze) or Jonas (Puy-de-Dome), for example, with the rich and precious objects of the sixth century furnished by certain English caverns, such as the celebrated Victoria Cave, near Settle, in Yorkshire. So it is expedient to call attention to some refuge tunnels very little known to the public, although, up to the present, they are the most extensive in entire France. We refer to those of Naours, in Somme, near Canaples, to the north of Amiens.

They have recently been rediscovered under circumstances curious enough to be recalled. It was known vaguely through tradition that there existed under the soil of Naours some ancient quarries utilized of old as places of refuge in time of war; but the location of their outlets, long ago filled in or obstructed, had been forgotten. In 1887, a priest particularly fond of archæological studies, Abbot Danicourt, former military almoner and author of a History of Ham, was appointed curate at Naours. He had heard tunnels spoken of, and, desirous of searching for them, was, by force of perseverance, fortunate enough to find them. He had, moreover, the persuasive talent to interest in this enterprise all the inhabitants of his parish, who, for four consecutive years, furnished him with the equivalent of 6,000 days of labor. The digging out or exposure of four ancient outlets of thirty streets or galleries exceeding more than a kilometer in total length, of 250 distinct chambers, of three chapels with their altars, of a water well, of six ventiducts, of a quantity of archæological objects left by the ancient occupants, and, in a word, the complete exhumation of a true subterranean village, effected without any subsidy, either public or private, was the fruit of this vast and disinterested labor—a remarkable example of the happy results that can be obtained through the union of an intelligent individual initiative and willingness on the part of many others.

During the course of June, 1888, Abbot Danicourt found in the national archives a census of the district of Naours dated 1331, and derived from the abbey of Corbie. In this, mention is made of the quarries, which must, therefore, have been excavated before the Hundred Years' War. So the abbot concluded that just as tradition claims, work on the quarries of Naours was begun at the epoch of the Norman invasions, and that this work was pursued and finished in great part under the feudality. The materials were gradually utilized, and habitations or refuges were prepared for the invasions or wars to come. The internal arrangement evidently demonstrates this.

The fact is that these tunnels have not, as a general thing, the aspect of ordinary quarries. It is plainly to be seen that, while extracting the stone, great care has been taken to leave solid intervals of rock much larger than a pure and simple exploitation would have required. Things were so arranged as to leave a place for chambers and cross streets with a certain regularity. The streets, bordered with cells, were excavated according to a preconceived plan. Their width (from 1 to 2 meters) and their height (2 meters on an average) are in nowise those proper to quarries exploited for the rock itself.

The proofs of habitation furnished by the tunnels of Naours are in reality of two sorts: First, those resulting from the arrangement of the places; and second, the objects collected during the work of excavation.

Into the first category enter: (1) The numerous chambers, generally 6 or 7 meters in length by 3 in width, formed here and there on the principal streets or galleries, and that have a form, a regularity and a symmetry that force us to consider them as anything but simple empty spaces left by the removal of the stone, and certain of which possess niches excavated into couches and closets that leave no doubt as to their adaptation to a prolonged sojourn.

(2) The hewn boundaries, and the apertures formed in the quite soft stone (white silicious chalk), doubtless for passing the fetters through that attached the cattle.

(3) The chapel with three small naves, which, in the gallery called Church Street, is provided not only with three rudimentary altars, but also with a holy water basin, the whole cut out of solid rock, as in the famous subterranean church of Saint Emilion in Gironde, although upon a much reduced scale.

(4) The dates incrusted with a thick patina engraved upon the walls, and seventy-eight of which date back to the Hundred Years' War.

(5) Walls of defense behind the doors, etc.

Of all the objects discovered, Abbot Danicourt has formed (without speaking of culinary debris, piles of ashes and bones of edible animals found in large quantity) a collection that comprises, among other things, door mountings and keys whose form shows them to be of the middle ages; a halberd of the time of Francis I; cocks of flint lock guns; heads of cross bow javelins; household utensils and instruments absolutely foreign to the quarry industry; fragments of plates and dishes and pottery; and finally, four series of coins—the first of the time of the League, including a valuable gold piece of Philip II of Spain; the second of the time of the Thirty Years' War, with the effigy of Louis XIII, dated from 1630 to 1640; the third of the beginning of the reign of Louis XIV; and the fourth of the year VII of the first republic—small change doubtless lost by the smugglers who, according to tradition, used these tunnels as a storage place for salt to defraud the gabel.

We may, upon the whole, consider as certain that during the Hundred Years' War, the War of the League and the Thirty Years' War, the inhabitants of Naours several times sought refuge in their tunnels against the aggressions of the English and Spanish.

This opinion was, so to speak, officially pronounced at the time of the visit that the French Archæological Society paid to Naours, on July 3, 1893, during its sixtieth meeting at Abbeville under the presidency of Count de Marsy. On April 29, 1895, Abbot Danicourt had the kindness to guide us into the innermost recesses of his tunnels. Struck, like all visitors, with their extent, their curious arrangement and their historic interest, we were enabled to ascertain, besides, that certain parts of them, at least in the lowest levels,

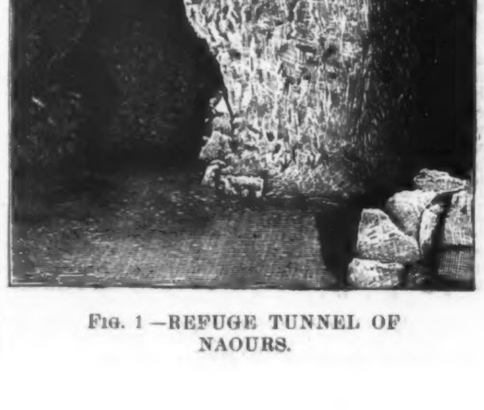


FIG. 1.—REFUGE TUNNEL OF NAOURS.

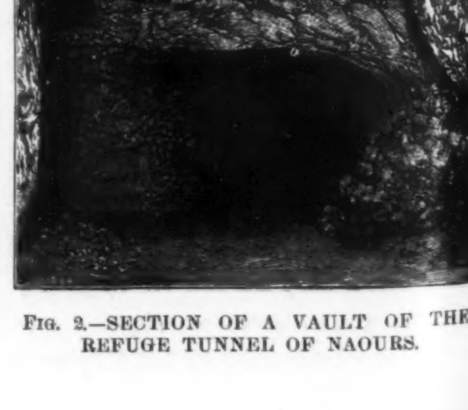


FIG. 2.—SECTION OF A VAULT OF THE REFUGE TUNNEL OF NAOURS.

were perhaps not hollowed out by the hand of man, but rather by the forces of nature.

Only last winter, not far from the present main entrance, in the western quarter of the tunnels, Abbot Danicourt, who is carrying on this work with the most laudable ardor, began the clearing out of a tortuous gallery of irregular section situated lower down than the majority of the artificial streets and most likely formed in the natural fissures of the rock. Now, at the very foot of the hill in which the quarries were excavated, formerly flowed, and flows still, after heavy rains, a stream called the Naourde, whose channel traverses the village of Naours. This channel is 10 or 12 meters below the entrance to the tunnels, no part of which at present cleared descends so low as this level.

We should be in nowise surprised if a continuation of the excavating in a downward direction would bring to light a more or less complex system of natural canals of varying width, serving, or having served of old, as a passage for the subterranean course of the Naourde. The water of the latter, in fact, must partially infilter, up stream, into impenetrable fissures of its right bank, which is formed by the chalky hill in which the quarries are located. The grotto of Miremont, in Dordogne, the subterranean course of the Iton, in Eure, and the quarries of Caumont, in Seine Inferieure, have shown us such natural aqueducts in formations of analogous ground.

Perhaps some day we shall be much surprised to meet, in the levels of the refuge tunnels of Naours, with another series of natural ramifications formed by water, according to the general law of the formation of caverns, at the expense of pre-existing fissures in the earth, but whose dimensions cannot just at present be surmised. Geology, thanks to the nature of the rock in this place, hydrology, on account of the absorption of the Naourde, and topography, in consequence of the relations of altitude, render such a hypothesis very acceptable, and we have strongly urged Abbot Danicourt not to lose sight of it in the continuation of his meritorious and curious researches under Naours.—La Nature.

[FROM SCIENCE PROGRESS.]

THE ZOOLOGICAL POSITION OF THE TRILOBITES.*

IN the discussion of the remaining points which we shall select for mention in the following pages we shall, therefore, assume that the organization of these early Crustacea, Apus and the Trilobites, can be deduced from that of an Annelid with the first segment bent round ventrally, so that the large prostomium points backward, while the pair of appendages, specialized into sensory cirri, which were arranged one on each side of it in its original anterior position, remained on each side of it in its new ventral position, and became the first pair of antennæ of the Crustacea. In making this assumption, we are in no sense rushing ahead of our facts; not only does the evidence already brought forward justify us, but the points still to be dealt with confirm it in every instance. We state it thus definitely at this point chiefly in order to facilitate the comprehension of other details.

Having mentioned the large labrum which has long been known, and the antennæ attached at each side of it, the structure next in order, from before backward, is the under lip, which has recently been described by Dr. Beecher for the first time, as it appears in Triarthrus.

The under lip is simply the ventral border of the mouth, but in Triarthrus it is bent round as a small ridge projecting backward. In the original annelidan ancestor, with its anteriorly placed mouth, the dorsal border was formed by the large fleshy labrum or prostomium, while the ventral border, in all probability, showed no specialization whatever. As soon, however, as the first segment bent round ventrally, so that the mouth opened backward, the prostomium would take up the position of the labrum in Apus and the Trilobites, and the ventral border would form a small ridge-like under lip, also pointing backward, such as is actually found in Triarthrus. This under lip in Triarthrus is thus another slight confirmation of our deduction of the primitive Crustacea from an Annelid with its first segment bent round ventrally.

This under lip of Triarthrus is, however, no longer the simple ridge we must assume it to have been in its most primitive condition. It already shows a tendency to form lateral lobes. These small lobes, so insignificant in themselves, become important when studied comparatively. Their remarkable development in Apus reveals to us their function. They supply us with an interesting illustration of the dependence of morphology upon physiological need. In order to make this clear we shall have to make a brief digression to explain the new method of feeding which the bending round of the mouth implies.

The chaetopod Annelids, with their anteriorly placed mouths, largely feed by protruding an evaginable, and generally armed, portion of the pharynx. This is thrust out, seizes the prey, and is then withdrawn back again into the mouth. Any new position adopted by the mouth could only be in adaptation to some new method of feeding. We have, therefore, to see what advantages would be afforded by the bending round of the mouth ventrally backward. There is an immense amount of nutrient matter, animal and vegetable, which, coating the rocks and weeds, is quite unattainable by the shooting out of a proboscis. Any Chaetopod, therefore, learning to browse in such a way as to be able to take advantage of this hitherto unattainable supply of food, would stand a good chance in the race for life. I have, for instance, long thought that the great phylum of the Mollusca might be deduced, in a manner which I think can be worked out in detail, from Chaetopods which early learnt to feed by scraping the surfaces of things with the ventral edge of the protrusible pharynx, this, in time, becoming specialized as a radula. And so I believe that the great phylum of the Crustacea arose from Chaetopods also becoming adapted to take advantage of the same food supply, but in a manner very different from, and less efficient than, that adopted by the Mollusca. The ancestor of the crustacean phylum used its appendages as the instruments for obtaining supplies. The food raked from each side by the parapodia into the middle line was then pushed forward toward the mouth, bent round to receive it. This new function of the parapodia, which were primitively protective on account of their bristles, and locomotory as swimming plates, would soon lead to modifications of structure, which we are not yet in a position to describe in detail. The most primitive phyllopodan limbs with which we are acquainted, viz., the larval limbs of Apus, represent the earliest known stage in the transformation of the annelidan parapodium into the crustacean legs. They are flat, unjointed skin folds, carrying on their dorsal edges a pair of processes, one of which has strong claims to be the typical gill of an annelidan parapodium. Their ventral edges are deeply notched so as to form a series of lobes. The proximal lobe of the series is distinct from the rest, and can safely be taken to be the original ventral parapodium.* We further find in Apus that these innermost lobes (the ventral parapodia), forming a longitudinal series along each side of the middle line, are twisted round in such a way as to show that in addition to assisting to rake food together, they also serve for pushing it forward toward the mouth.

Having thus briefly described the new method of feeding of the ancestor of the crustacean phylum, we must return to the ridge-like metastoma of Triarthrus and its commencing modifications.

It is not difficult to see that, in its most primitive, ridge-like form, such a metastoma would be a barrier across the ventral surface, hindering the pushing forward of food into the mouth by the appendages. In order to perfect this method of feeding, this ridge would have to be modified. In Apus we find, in fact, that it has almost entirely disappeared in the middle line, while its lateral ends have developed into two fleshy projections looking somewhat like jaws, and often mistaken for such. Thus modified, the metastoma, on the one hand, ceases to be a hindrance against the traveling forward of food along the middle line into the mouth, while, on the other hand, its lateral lobes help to prevent the escape of food on either side when the mouth is reached. Now the metastoma of the Trilobite Triarthrus is especially interesting because it still shows the primitive ridge right across the ventral surface, not yet smoothed down in the middle line, while the two ends are only beginning to form their lateral lobes. The discovery of the metastoma of Triarthrus is thus another confirmation, this time not only of the relationship between Apus and the Trilobites, but also of their common derivation from an Annelid modified in the manner described.

Turning now to the limbs, they offer so many striking confirmations of the same conclusions that they alone are, it seems to me, sufficient to place the relationships here set forth beyond further question. We will briefly note some of the leading points.

(a) Our deduction of both Apus and the Trilobites from a common annelidan ancestor, from which neither was very far removed, requires that all the appendages except the first pair should have been behind the metastoma. This primitive condition, lost in Apus by the metastomial lobes stretching behind the third pair of limbs, is apparently found in Triarthrus.

(b) The series of appendages behind the metastoma should have been structurally alike, that is, there was no original specialization of those limbs nearest the mouth into mandibles and maxillæ as distinct from locomotory appendages. This primitive condition is retained by Triarthrus.

(c) While the first pair of appendages is reduced to a pair of cirri, one on each side of the labrum, the pairs immediately following are, in the Chaetopods, often reduced in size, progressively increasing till a maximum is reached. This primitive annelidan characteristic is found in Triarthrus, as well as in the related Limulus and Eurypterus; the sixth pair in the last two animals, as well as in Apus, being the most powerfully developed.

(d) Their hypothetical annelidan ancestor requires that both the Trilobites and Apus originally possessed primitive phyllopodan appendages. This has now been fully established by Dr. Beecher's discovery that the rudimentary limbs under the pygidium of two Trilobites, Triarthrus and Trinucleus, were phyllopodan, like the larval and rudimentary limbs of Apus.

(e) Such phyllopodan limbs must have extended along the whole length of the body as far as the metastoma. In Apus the phyllopodan type persists as far forward as the sixth segment, and can be faintly traced as far as the third, while Triarthrus teaches us, as we have seen (b), that the homogeneity of the limbs extended originally as far forward as the second pair. We have thus a conclusive proof that the common ancestor of both Apus and the Trilobites possessed simple phyllopodan appendages along the whole length of the body from the second segment.

These are some of the new points relating to the appendages as a whole, which arise out of a comparison of Dr. Beecher's discoveries with the known structure of Apus. There are many other confirmatory points of interest and importance which, if space allowed, might be adduced, but these are the ones which I have selected to emphasize, because they demonstrate once for all the affinities of these early Crustaceans to one another as common derivatives of an annelidan ancestor, from which neither is far removed.

Having thus briefly traced the Trilobites and their existing ally, Apus, to their common ancestral form, it remains for us to indicate, as far as our knowledge goes, their respective divergent specializations. However interesting it is to run them back to their common form, it is, perhaps, even more interesting to trace the lines of advance leading them to their different fates—the Trilobites to die out with a single survivor in Limulus,† Apus not only to survive to this day, but to give rise to the whole family of modern Crustacea.

Before describing the lines along which the two forms must have diverged, one other very early specialization of the common racial form has to be mentioned. The bending round of the prostomium with the antennæ, and of the parapodia with their protective bristles toward the ventral surface, left the dorsal surface quite exposed; some compensatory arrangement for protection was, therefore, needed. It is not improbable that the dorsal organ, which in the larva is comparatively of great size and forms a shield-like plate of excretory cells, was protective. In addition to this, however, the skin of the dorsal surface at a very early stage not only thickened, but grew out laterally into folds which roofed the animal over, while the skin of the under surface retained its primitive delicacy and softness, hence its almost universal absence in the fossil Trilobites. The earliest arrangement of these dorsal shields must for the present remain matter of conjecture. The very earliest stage, both ontogenetic and phylogenetic, known to us is that presented by the minute larva of Olenellus, the most primitive Trilobite. We there find an enormous skin fold forming a crescent round the front and sides of the first segment, the three following segments having much smaller lateral folds (pleuræ), which, fusing with this crescent fold of the first segment, together form a roof almost completely protecting the young Olenellus.* There is some reason to believe that primitively this dorsal roof was confined to the anterior end of the body covering the first five segments. From this common stage the Trilobites and the Crustacea proper parted company.

The Trilobites seem to have perfected the browsing manner of life, spending the whole of their active life in crawling over the sea bottom. The primitive dorsal shield at the anterior end of the body repeated itself on every subsequently developed segment in the form of a pair of sharp blade-like pleuræ. The Trilobites thus browsed securely under a great jointed roof, each joint being provided with a pair of formidable lateral spines. The development of these enormous pleuræ may have early tended to limit the number of segments. In adaptation to this settled creeping manner of life, the phyllopodan limbs became early transformed into filamentous walking legs. The limbs, commencing from the second pair, were used as locomotory (walking) appendages (cf. Triarthrus, Limulus). Only under the pygidium in the rudimentary segments did a few of the appendages remain phyllopodan. The function of raking together the food and pushing it forward to the mouth must have been entirely carried on by the ventral branches of the parapodia. In Limulus we find these "gnathobases" highly developed and carrying a cirrus-like appendage, while in Triarthrus (cf. Dr. Beecher's figures) those nearest the mouth are plate-like jaws, while those on the trunk segments have a remarkable leg-like appearance which can hardly be accidental. I would like to suggest that some special development of these gnathobases might be expected in the Trilobites, that is, if the dorsal leg portions were purely locomotory.

These are a few of the more important points of interest in the specialization of the Trilobites. The type was plastic enough to give rise to endless small variations, but apparently not plastic enough to readapt itself to certain new, and at present unknown, changes in the conditions of life; hence the extinction of the race.

The other great branch of these primitive annelidan Crustacea has had a very different fate. The head shield was not primitively repeated along the body as pleuræ, but grew backward as a great fold, forming a carapace which protected the back and sides of the trunk. The trunk segments remained simply cylindrical and persisted for a time in far greater number than in the Trilobites. The limbs further remained phyllopodan as swimming plates. While, however, thus retaining primitive conditions in the trunk, the limbs of the anterior or head segments underwent a very marked specialization. The first pair remained as simple antennæ, the second pair degenerated and lost their jaw plates, but ultimately developed their sensory functions to become the second antennæ of the typical Crustacean. The third pair lost their locomotory portions and became the powerful mandibles working between the labrum and labium (or labial lobes). The two following pairs also more or less completely lost their locomotory functions, the basal portions persisting as accessory jaws, the maxillæ. This formula for the head limbs, seen in its most primitive condition in Apus, became from henceforth the typical mouth formula of the Crustacea.

From such a form as this, all the modern Crustacea can be deduced.† The segmentation became more specialized and consequently less rich, the limbs lost their primitive phyllopodan characters, the two pairs of antennæ traveled forward to the anterior edge of the head; the mouth and mouth parts also moved forward, causing the almost complete obliteration of the great labrum. The metastomial lobes persist as the "paragnathes," while the great fleshy mandibles of Apus became hard chitinous plates. The degenerate locomotory portions of the maxillæ became the palps, while, in some forms, a certain number of trunk limbs, the ventral branches of which, in the primitive form, served to push food forward toward the mouth, move forward and join the maxillæ, as accessory jaws, the maxillipedes. The great carapace has undergone many variations; in some cases it has degenerated, in others it has given rise once more to a system of pleuræ along the trunk by segmental repetition, and forms such as the Isopods have arisen, closely resembling the Trilobites, and perhaps to some extent taking their place in the modern seas.

From this brief account of the rise of the modern Crustacea from Apus, it follows that the Trilobites are in reality pre-crustacean. They represent a stage more primitive than Apus, i. e., nearer to the original annelidan ancestor of the whole phylum.

While the immediate ancestors of Apus and of the Crustacea proper retained the power of swimming freely from place to place, the Trilobites became specialized for a creeping manner of life, apparently perfecting along one line the new method of feeding, which, as above described, was the physiological change leading to the subsequent morphological transformation of the Chaetopod into the Crustacean.

We may therefore describe the Trilobites as special-

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* Continued from SUPPLEMENT, No. 1084, page 16534.

* I have figured such a limb, viz., the last limb in Apus productus, in the Apodidæ, Fig. 20, p. 48.

† I am inclined to believe that the Ostracoda also may be deduced from larval Trilobites in which the head shield folded longitudinally to form the bivalve shell (cf. the Apodidæ, p. 236).

* From such extremely primitive crustacean, or rather pre-crustacean, larvæ with their great circular roofs, I would deduce the Ostracoda and the enigmatical palæozoic Cyclus.

† Cf. on this Prof. K. Grobben, Sitzungsber. d. K. Akad. Wien, vol. ci, 1892, pt. 1.

ized links in the chain which connects the Crustacea with their annelidan ancestors.

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H. M. BERNARD.

THE ICE AVALANCHE OF THE GEMMI PASS (SWITZERLAND).

By C. S. DU RICHE PRELLER.

IT is a noteworthy fact that although Alpine glaciers have during the last few years not shown any very marked oscillations,* the Central Alps have, since the year 1892, been annually visited by a disaster caused directly or indirectly by the bursting or failing of a glacier. Thus in 1892 the Tête Rousse glacier of the Mont Blanc group swept away the baths of St. Gervais; in 1893 the village of Taesch, between Visp and Zermatt, was devastated by the torrent of the Weingarten glacier, not far from the village of Randa, which was destroyed by a glacier avalanche in the year 1819; again, in 1894, the torrent of the Crête glacier (Grand Combin group, Rhone Valley) suddenly poured its flood into the River Dranse, and thereby endangered the town of Martigny; while this year the record has been swelled by the avalanche of the Altels glacier on the north side of the Gemmi Pass, in the Bernese Oberland.

The scene of this last catastrophe is at an altitude of 1,950 meters (6,400 ft.) above sea level, about 6 kilometers (4 miles) above Kandersteg and about the same distance below the summit of the Gemmi Pass, familiar to tourists crossing the divide of the Aare and Rhone watersheds by the Kander Valley and the bridle path from Kandersteg to the baths of Louèche.

Three glaciers descend from the summit of Altels 3,636 meters (11,926 ft.) above sea level, one in a northerly, another in a southwesterly, and a third, the middle one, in a northwesterly direction. It is this last, a so-called suspended or overhanging glacier, which, about 5 A. M. on September 11, detached itself from the upper end at an altitude of 3,300 meters (10,823 ft.), or about 1,000 ft. below the summit, swept down a declivity 1,400 meters (about 4,600 ft.) in vertical depth, was thrown up 400 meters (1,300 ft.) to the summit level of the precipitous mountain ridge on the opposite side of the valley, and thence rebounding, fell and spread in fan shape on a rich and extensive pasture, known as the Spitalmatte, which is now buried under ice and rock debris over an area of 2 square kilometers (nearly 1 square mile) to an average depth of 2 meters (about 6 ft.) The disaster involves, besides the ruin of the valuable Alpine pasture and the destruction of several chalets, the loss of six lives and of upward of 150 head of cattle.

The entire distance covered by the avalanche, including the rebound, was about 5 kilometers, or 3 miles. The angle of inclination of the glacier itself was about 30°, that of the declivity immediately below is 42°, while the upward slope of the Steinmatte is 9°, and the inclination of the Weissfluh and Gellihorn ridge is no less than 58°. The line of rupture of the glacier below the summit of Altels is distinctly marked by an ice wall about 40 meters (130 ft.) in depth, having the form of a concave curve, while the opposite mountain ridge bears numerous traces of the avalanche having been dashed against it and hurled up to its summit level.

Among the many remarkable and instructive features of this ice avalanche, I may point out the following:

1. The rupture of the glacier was caused by two partial cross rents, which, during the protracted heat, gradually extended and joined, the altered appearance of the glacier having been noticed from a distance the day before the disaster. The hot southerly wind ("Foehn") which blew the whole night, promoted, as it always does, the melting of the ice, and thus aided in setting the lower separated part of the glacier in motion.

2. In the descent from Altels the avalanche crashed through and carried bodily along with it an extensive plantation, a fact which shows once more, if proof were wanted, that forest plantations are no effectual protection against avalanches.

3. The avalanche in its descent completely cleared the Schwarenbach torrent, which shows that it moved practically as a solid mass. Moreover, in its rebound from the opposite mountain ridge and in its fall on the Spitalmatte, it buried the Gemmi bridle path, but stopped short of the torrent, thereby fortunately preventing the latter from being banked up to a temporary lake and endangering the valley below.

4. The prodigious velocity of the avalanche and the pressure of the column of air displaced by and pushed in front of it are attested by a distinct blast zone of débris, such as the remains of chalets, human bodies, cattle, etc., blown to a considerable height and distance.

5. The volume of the detached glacier and rock débris, about 1 kilometer in length, 100 meters in width and 40 meters in depth, is about 4,000,000 cubic meters or tons, which estimate agrees pretty accurately with the volume of débris deposited on the Spitalmatte, viz., about 2 square kilometers to a depth of 2 meters. If we consider the avalanche a moving mass possessing momentum, its energy is given by the formula

$$E = w\,h,$$

where h is the height fallen through. The mean depth of fall in the present case was 1,100 meters, hence the total energy expended was 4,400,000,000 meter tons. If half of this available work was expended on the resistances ove come by the descent, there would still be left 2,200,000,000 meter tons available, which, acting against similar resistances, would be sufficient to raise the whole mass to a height of 280 meters on the other side of the valley.

The velocity of the fall measured vertically and without taking into account the various retarding resistances, works out 148 meters (485 ft.) per second, and that of the rise 90 meters (295 ft.) per second. Hence the avalanche in falling covered a distance of 3 kilometers (on an incline of 42°, or about 1 in 1) in 20 seconds, in rising a distance of 1 kilometer in 10 seconds, and in rebounding, also a distance of 1 kilometer, in 10 seconds, total about 40 seconds. If to this we add 50 per cent. for the various retarding resistances, the time within which the ice avalanche did its work of destruction is not more than one minute.

By a singular coincidence, a similar ice avalanche is recorded as having occurred at the same spot on the same day about 100 years ago, viz., in 1782. The present disaster falls short of the rock fall of Elm (in the Glarus Alps), which occurred in 1881 on the same day, viz., September 11, and caused the loss of 114 lives and 79 buildings, the volume of débris being about double that of the Altels ice avalanche. Still the magnitude of the latter and the scale on which Nature works in the Alps may be gathered from the fact that the detached glacier swept down a declivity whose vertical height is 13 times that of St. Paul's Cathedral (365 ft.); that it was then hurled up to a height 4 times the elevation of that building; and that the volume of its débris under which the Alpine pasture is now buried would suffice to cover to a depth of 3 ft. the combined area (about 1,000 acres) of Regent's Park, Hyde Park and Kensington Gardens.—Engineering.

* Official measurements made in 1893, after a dry and hot summer, showed that out of 28 glaciers in Canton Valais (Rhone Valley) 14 had receded 3 to 28 meters, 3 had remained stationary, 10 had advanced 2 to 30 meters and only 1 had advanced 100 meters, or about 1 ft. per day.

JAMAICA DRAGON'S BLOOD.*

By HENRY TRIMBLE.

THE origin of this product was described in the Bulletin of the Botanical Department, Jamaica, No. 45, July, 1893.† As there stated, the tree is about thirty feet high, and when an incision is made in the bark, drops of red sap ooze out, which flow slowly down the bark and gradually harden.

The sample received by me from Mr. Fawcett was in small garnet-red pieces, transparent at the edges, and breaking with a resinous fracture. It much resembled the eucalyptus kino received from Australia.

On account of its solubility in water the product closely resembled some other varieties of kino, as well as the one just mentioned from Australia.

Warm water dissolved 95·95 per cent. of it; the insoluble portion, 4·05 per cent., consisted chiefly of adhering bark fiber.

The ash amounted to 2·36 per cent., and was found to consist of potassium, calcium, magnesium, and sulphuric, carbonic and phosphoric acids. There were found 34·85 per cent. of tannin and 25·40 per cent. of moisture, which would indicate 46·71 per cent. of tannin in the absolutely dry substance. The balance consisted chiefly of gum. A complete statement, therefore, might be made as follows:

	Per cent.
Tannin	34·85
Moisture	25·40
Ash	2·36
Insoluble	4·05
Gum, etc.	33·34
	100·00

The tannin was separated from the gum with great difficulty, because of the ready solubility of each in water, and because the tannin caused some of the gum to go into solution in absolute alcohol, and also in a mixture of alcohol and ether. Agitation of the water solution with acetic ether, even in the presence of salt, did not serve to separate the tannin from the gum, as the latter substance seemed to withhold the former. The close association of the two principles was finally broken up to some extent by agitation of the coarsely powdered sample with sand and acetone. Upon allowing the mixture to rest, the gum separated as a jelly-like mass. The acetone solution when separated, and the solvent recovered by distillation, left the tannin in a porous condition, but still admixed with some gum. From this residue the greater part of the still adhering gum was separated by treatment with absolute alcohol. The solution was filtered from the gum left undissolved by that solvent and distilled to dryness, and the residue rendered porous by solution in a mixture of alcohol and ether and subsequent rapid vaporization of those solvents by distillation under reduced pressure.

The ultimate composition of the pure tannin will be seen by the following average of three analyses:

	Per cent.
Carbon	58·91
Hydrogen	4·80
Oxygen	36·29
	100·00

An aqueous solution of the tannin gave the following reactions:

Lime water......Purplish-pink color, becoming a brownish ppt.
Bromine water..Yellow ppt.
Ferric chloride ..Green ppt. and color.

The composition, as well as the reactions, indicate it to be very closely related to oak bark tannin, if not identical with it. The sample does not agree in composition or properties with the dragon's blood from the East Indies; it does, however, closely resemble the kinos, and should more properly be classed with them.

It will, no doubt, if found in sufficient quantity, have some use in medicine as a kino, and it might be used, in case its price should warrant it, in the manufacture of leather, although such substances containing gum usually make a soft product.

* From the Bulletin of the Botanical Department, Jamaica, Vol. II, p. 161.

† A history of this substance was given by Fluckiger, Pharmaceutical Journal, 1893, p. 108, and Am. Jour. Pharm., 1893, p. 460.

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